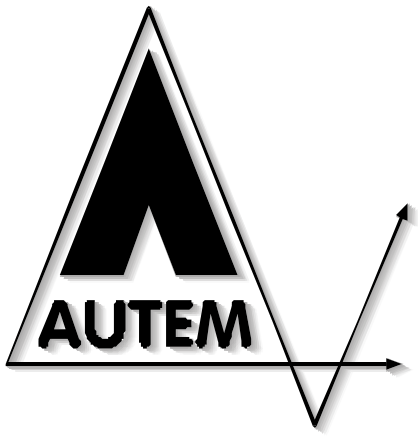
PLC-ANALYZER *pro* 4

User Manual



User Manual *PLC-ANALYZER pro 4*

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1st Edition 2001

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Table of Contents

1 INTRODUCTION 1-1

1.1 Overview 1-1
1.2 Operational area of PLC-ANALYZER pro 1-2
1.3 Performance characteristics 1-2
1.4 Typical operation 1-3
1.5 Help 1-4
1.6 Technical Support 1-4

2 INSTALLATION 2-1

2.1 Hardware and software requirements 2-1
2.2 Installing the basic module and PLC driver 2-1
2.3 Later installation of PLC drivers 2-2
2.4 Copy protection 2-2
2.5 Starting the program 2-3

3 CONFIGURATION 3-1

3.1 PLC driver 3-1
3.2 Load symbols 3-2
3.3 Options 3-3
3.3.1 Signals 3-3
3.3.2 Directories 3-4
3.3.3 Language 3-5
3.3.4 Toolbars 3-5
3.4 Remote maintenance 3-7
3.5 Tools 3-7

4 DATA ACQUISITION 4-1

4.1 Address selection 4-2
4.2 Online signal selection 4-5
4.3 Trigger 4-7
4.3.1 Trigger on binary signals 4-7
4.3.2 AND / OR combination of trigger signals 4-8
4.3.3 Trigger on analog signals 4-8
4.3.4 Setting trigger properties 4-10
4.4 Scaling of register values 4-11
4.5 Modes of data acquisition 4-12
4.5.1 Cycle-precise acquisition 4-13
4.6 Starting data acquisition 4-13

5 SIGNAL DISPLAY AND ANALYSIS 5-1

5.1 Opening a signal file 5-1
5.2 Signal selection 5-2
5.3 Scaling of register values 5-4
5.4 Signal cursor 5-5
5.5 Time information 5-6
5.5.1 Absolute and relative time display 5-6
5.5.2 Setting the time base 5-6
5.5.3 Time difference measurement 5-7
5.6 Search functions 5-8
5.6.1 Find trigger 5-8
5.6.2 Find time 5-8
5.6.3 Find bit pattern 5-9
5.6.4 Search for analog value 5-9

5.6.5 Find edge 5-10
5.7 Comparing signal files 5-11
5.8 Signal statistics 5-12
5.9 Adapting signal display 5-13
5.9.1 Shifting signals 5-14
5.9.2 Changing signal color 5-14
5.9.3 Labeling the signals 5-14
5.9.4 Modifying symbol addresses and comments 5-14
5.10 Saving a signal file 5-14
5.10.1 Saving an extract 5-15
5.11 Printing a signal file 5-15
5.12 ASCII-Exporting signal files 5-17
5.12.1 Export as graphic (bitmap) 5-17
5.12.2 Export as ASCII text 5-17
5.12.3 Graphical evaluation of signal data in MS-EXCEL 5-18

6 REMOTE DIAGNOSIS 6-1

6.1 Remote diagnosis with terraLink® 6-1
6.2 Remote diagnosis with remote PC 6-1

7 DRIVER APPENDIX SIEMENS SIMATIC S5 7-1

7.1 Installation 7-1
7.1.1 Installing additional hardware 7-1
7.1.2 Installing additional software 7-1
7.2 Configuring the PLC driver 7-2
7.3 Data acquisition 7-3
7.3.1 Supported PLC models and CPUs 7-3
7.3.2 Recordable PLC addresses 7-3
7.3.3 Time behaviour and particularities 7-4
7.4 Cycle-precise acquisition 7-5
7.4.1 Address entry 7-5
7.4.2 Trigger condition entry 7-5
7.4.3 Starting acquisition 7-6
7.4.4 Particularities of signal display and analysis 7-8

8 DRIVER APPENDIX SIEMENS SIMATIC S7 8-1

8.1 Installation 8-1
8.1.1 Installing additional hardware 8-1
8.1.2 Installing additional software 8-2
8.2 Configuring the PLC driver 8-2
8.3 Data acquisition 8-3
8.3.1 Supported PLC models and CPUs 8-3
8.3.2 Recordable PLC addresses 8-3
8.3.3 Time behaviour and particularities 8-4
8.4 Cycle-precise acquisition 8-5
8.4.1 Installation of additional software 8-5
8.4.2 Installation of additional Hardware 8-5
8.4.3 Configuration of PLC-driver for cycle-precise acquisition 8-5
8.4.4 Input of addresses 8-6
8.4.5 Starting acquisition 8-7
8.4.6 Particularities of signal display and analysis 8-9

Table of Figures

Fig. 1-1 PLC-ANALYZER pro 1-1
Fig. 2-1 The initial screen 2-3
Fig. 3-1 Option menu 3-1
Fig. 3-2 Configuring the PLC driver 3-1
Fig. 3-3 Selecting the PLC driver 3-2
Fig. 3-4 Symbol file assignment 3-2
Fig. 3-5 Selecting the standard directories 3-4
Fig. 4-1 Definition of a new project 4-1
Fig. 4-2 Entering signals to acquire 4-2
Fig. 4-3 Define address set 4-4
Fig. 4-4 Selecting signals for online display 4-5
Fig. 4-5 Define new online selection 4-6
Fig. 4-6 Entering trigger conditions 4-7
Fig. 4-7 Principles of analog triggering (< , > , = , <>) 4-9
Fig. 4-8 Setting trigger properties 4-10
Fig. 4-9 Register scaling for online display 4-11
Fig. 4-10 Setting the acquisition mode 4-12
Fig. 4-11 Signal acquisition with graphics and text online window 4-14
Fig. 5-1 Opening a signal file 5-1
Fig. 5-2 Signal file display 5-2
Fig. 5-3 Selecting signals to display 5-3
Fig. 5-4 Scaling of register values 5-4
Fig. 5-5 Time information 5-6
Fig. 5-6 Activated time difference measurement 5-7
Fig. 5-7 Find trigger 5-8
Fig. 5-8 Find time 5-8
Fig. 5-9 Find bit pattern 5-9
Fig. 5-10 Find edge 5-10
Fig. 5-11 Printer selection window 5-15
Fig. 5-12 Printout of a signal file (not to scale) 5-16
Fig. 5-13 Export in ASCII format 5-17
Fig. 5-14 Example of an exported signal file (extract) 5-18
Fig. 5-15 Logarithmic representation of PLC analog signals with EXCEL 5-19
Fig. 5-16 3D representation of PLC analog values with EXCEL 5-19
Fig. 5-17 Discrete signals with EXCEL 5-20
Fig. 7-1 Driver settings (Siemens SIMATIC S5) 7-2
Fig. 7-2 Message before modifications in the AD for setting "With AD safety stop" 7-6
Fig. 7-3 Message before modifications in the AD for setting "No AD safety stop" 7-6
Fig. 7-4 Cycle-precise acquisition status 7-7
Fig. 7-5 Message before modifications in the AD for setting "With AD safety stop" 7-8
Fig. 7-6 Message before modifications in the AD for setting "No AD safety stop" 7-8
Fig. 8-1 Driver settings (Siemens SIMATIC S7) 8-3
Fig. 8-2 Driver settings for cycle-precise driver (SIMATIC S7) 8-6
Fig. 8-3 Message before modifications in the AD for setting "With AD safety stop" 8-7
Fig. 8-4 Message before modifications in the AD for setting "No AD safety stop" 8-8
Fig. 8-5 Message before modifications in the AD for setting "With AD safety stop" 8-8
Fig. 8-6 Message before modifications in the AD for setting "No AD safety stop" 8-8

List of Tables

Table 3-1 Setting signal options 3-4
Table 3-2 Toolbar icons 3-6
Table 4-1 Address syntax SIMATIC S7 4-3
Table 4-2 Trigger operator 4-8
Table 4-3 Modes of data acquisition 4-13
Table 5-1 Signal cursor 5-5
Table 5-2 Statistical evaluation of a bit address 5-13
Table 5-3 Statistical evaluation of a register address 5-13
Table 7-1 Overview of the supported SIMATIC S5 models 7-3
Table 7-2 Address syntax SIMATIC S5 7-4
Table 7-3 Status display cycle-precise recording S5 7-7
Table 8-1 Interface types SIMATIC S7 8-2
Table 8-2 Address syntax SIMATIC S7 8-4
Table 8-3 Driver Settings 8-6

1 Introduction

Welcome to PLC-ANALYZER pro 4, the software logic analyzer that gives you valuable help in solving automation problems.

This manual informs you on installation, operation, and application areas of this program.

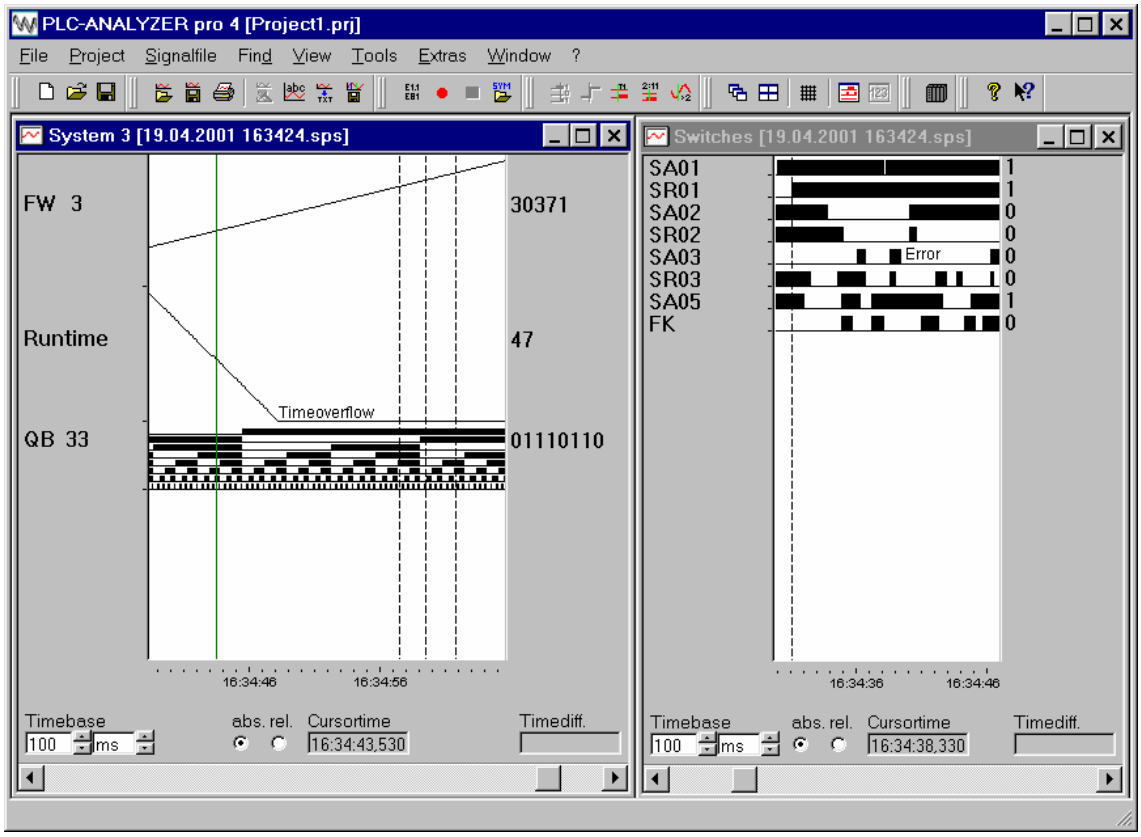


Fig. 1-1 PLC-ANALYZER pro

1.1 Overview

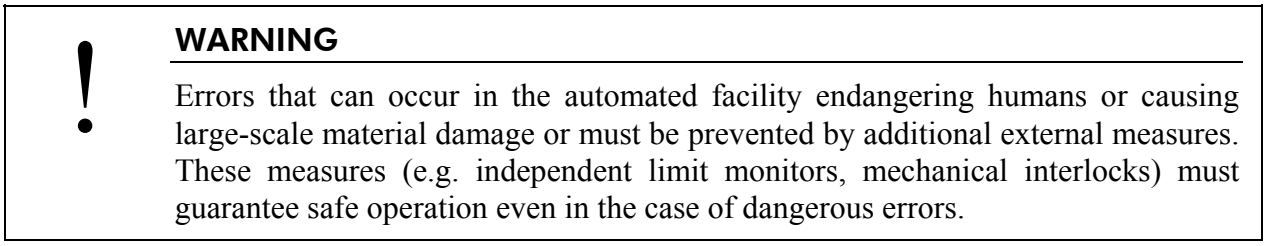
PLC-ANALYZER pro is a software tool for logic analysis and registration of measured values on facilities operated with a PLC (Programmable Logic Controller). It easily makes possible acquisition, display, and evaluation of PLC signals of all types. Among others, these signals include inputs, outputs, flags, timers, counters, and data words.

Equipped with the capabilities of a traditional logic analyzer, PLC-ANALYZER pro normally requires no software or hardware modification of the PLC for capturing signal data. This is a result of using the existing PLC protocol for data acquisition, whereby PLC-ANALYZER pro simply uses the typical hookup of programming units via serial connection or automation network. The programming unit (a PC) connected to the PLC can be used directly for data acquisition without further modification.

With PLC-ANALYZER pro the user can record all internal PLC signals, for example flags or timers, which are normally not accessible outside the PLC.

By using our special measurement interface **AD_USB-Box** external voltage and current signals, which are not available in the PLC, can also be recorded.

In this manual the MPI/PPI/PROFIBUS driver for Siemens SIMATIC S7 was selected in order to demonstrate program operation. The essential facts apply also to all other available PLC drivers, e.g. the ETHERNET driver for Siemens SIMATIC S7 or the AS511 driver for Siemens SIMATIC S5. You will find specific comments on the particularities of other PLC drivers in the corresponding driver appendix. It is important that you read the appropriate driver appendix before using a PLC driver. Please pay attention to the highlighted warnings on the possible dangers associated with the use of PLC-ANALYZER pro.



WARNING

Errors that can occur in the automated facility endangering humans or causing large-scale material damage or must be prevented by additional external measures. These measures (e.g. independent limit monitors, mechanical interlocks) must guarantee safe operation even in the case of dangerous errors.

1.2 Operational area of PLC-ANALYZER pro

- Fault analysis in PLC systems
- Finding and localizing sporadic errors
- Analysis and optimization / cycle time reduction
- Short-term and long-term registration of measured values
- Documentation for your quality assurance system (e.g. ISO 9000)
- Installation, development, technical service, training

1.3 Performance characteristics

- Data acquisition through the PLC programming unit interface or the automation network
- Acquisition of input, output, flags, timers, counters, data words, data block, etc.[1]
- Signal display in bit, byte, word, double word, or floating point format
- Addresses and trigger conditions can be specified during acquisition
- Simultaneous acquisition on several PLC systems (e.g. SIMATIC S5 + S7 or SIMATIC S5 + Bosch CL ...)
- Software solution, no additional hardware necessary
- No modifications in the PLC program necessary[2]
- Simultaneous acquisition of up to 160 1-bit signals or 20 word signals
- Cycle-precise acquisition with special drivers (optional)

[1] Varying terminology and restrictions possible according to PLC model
[2] An exception is cycle-precise acquisition.

- 32 1-bit signals or 8 analog signals simultaneously displayable, also logically combined
- Recording of the signal waveform on hard disk
- Trigger-controlled creation of signal files, continuous recording or manually controlled recording
- Online signal display (similar to an oscilloscope)
- Combined signal display using individual windows
- Online display in graphic or text format
- Trigger conditions can be specified with AND/OR combinations
- Definition of several triggers is possible, cascading
- Pretrigger and posttrigger time can be set by user
- Pretrigger, intrigger and posttrigger functions. Combined AND/OR logical operations with trigger conditions
- Trigger on register value
- Search for trigger, edge, bit pattern, and time
- Stopwatch functions
- Relative and absolute data time
- Flexible register scaling and conversion to physical units
- Uses symbolical address names from the PLC programming software
- Project files for pre-configuring and automating data acquisition runs
- S7-PLCSIM supporting
- Printout of signal files
- Export signal files as bitmap graphics (.bmp) or text (ASCII)
- Multilingual
- Worldwide remote diagnostics in connection with **terraLink**®
- Recording of external voltage and current possible in conjunction with **AD_USB-Box** (USB-Port)
- Capable of being controlled remotely via Internet or telephone line (e.g. by NetMeeting, pcAnywhere ...)

1.4 Typical operation

A typical application run of PLC-ANALYZER pro could look like this:

- Connect PC with the PLC programming unit interface
- Select signals to record
- Select signals to be displayed on the screen
- Set trigger combinations to freeze the data being recorded
- Start data recording
- End data recording
- Evaluate and analyze recorded signals in graphical display
- Use recorded signals to calculate time intervals

1.5 Help

You have access to a convenient online help for PLC-ANALYZER pro. To activate help just select the menu item *Help topics* in the help menu. A help window appears with important information and comments on program operation.

If you need detailed help on a specific window, simply press the F1 key when the window is active.

Direct help on an individual dialog element can be obtained by positioning the mouse over the element and clicking the right mouse key.

1.6 Technical Support

Check the online help and this manual if you run into difficulty when using PLC-ANALYZER. There is a FAQ list at our Web site **http://www.autem.de** containing answers to frequently asked questions.

Please contact our technical support if you cannot solve the problem.

Technical support AUTEM:

Tel. (+49) 4921-9610-0
Fax (+49) 4921-9610-96
eMail support@autem.de

Please have the following information at hand in addition to an **exact error description**:

- Version- and serial number of PLC-ANALYZER pro
- Model and exact type description of the PC or programming unit, release number
- Amount of memory (RAM) and free space on the harddisk
- Exact version of operating system (e.g. Windows 95 Version 4.00.950 B)
- PLC model and CPU type (e.g. SIMATIC S5-135U / CPU 922) and release number

NOTE

Don't forget to send in the registration card! Otherwise you won't be able to take advantage of our support hotline.

2 Installation

2.1 Hardware and software requirements

To operate PLC-ANALYZER pro 4.0 the following minimal configuration is necessary:

- IBM compatible PC with Pentium 100
- Windows 95/98/ME/2000/XP, Windows NT 4.0
- 32 MB RAM
- Hard disk with approx. 40 MB free space

Depending on the PLC driver, the computer used to acquire data may have to satisfy additional requirements such as the installation of a network card and supplementary device drivers. For such cases please read Chapter *Installation* in the corresponding driver appendix.

2.2 Installing the basic module and PLC driver

Install first the PLC-ANALYZER pro basic module on your PC:

- Insert diskette 1 of the basic module PLC-ANALYZER pro in a floppy disk drive
- Click on the Windows *Start* button on the task bar
- Select menu item *Run*
- Type `A:\SETUP` and start the installation program with *OK*

After the installation program starts a series of dialog windows appear in which you are requested to make some settings. Simply follow the instructions given by the installation program.

After installing the basic module you will be asked to insert a PLC driver diskette. You can install several PLC drivers, if you wish. Configuration of PLC drivers is described in *3.1 PLC driver*.

2.3 Later installation of PLC drivers

You may wish to install a new driver obtained at a later date. This can be done with your current version of PLC-ANALYZER pro. Select *PLC driver* in the *Options* menu. Then click the *Add* button in the PLC driver window. If your desired driver does not appear in the list, then click on the *Diskette* button to install the driver. Insert your driver diskette into the diskette drive and click on *OK*.

You can install several PLC drivers one after the other. Configuring and switching among drivers in PLC-ANALYZER pro will be described in detail in *3.1 PLC driver* and in the driver appendix.

2.4 Copy protection

PLC-ANALYZER pro uses a key diskette for copy protection. Insert the supplied key diskette in your computer's diskette drive before you use the program. Leave the diskette in the drive during the entire time you use the program.

If you should forget to insert the key diskette into the disk drive, a message appears and you have the chance for corrective action.

2.5 Starting the program

NOTE

Please make sure that your computer's time and date are set correctly. Correct the values if need be.

Start PLC-ANALYZER pro simply by double-clicking on the PLC-ANALYZER pro 4 icon in the program group PLC-ANALYZER pro.

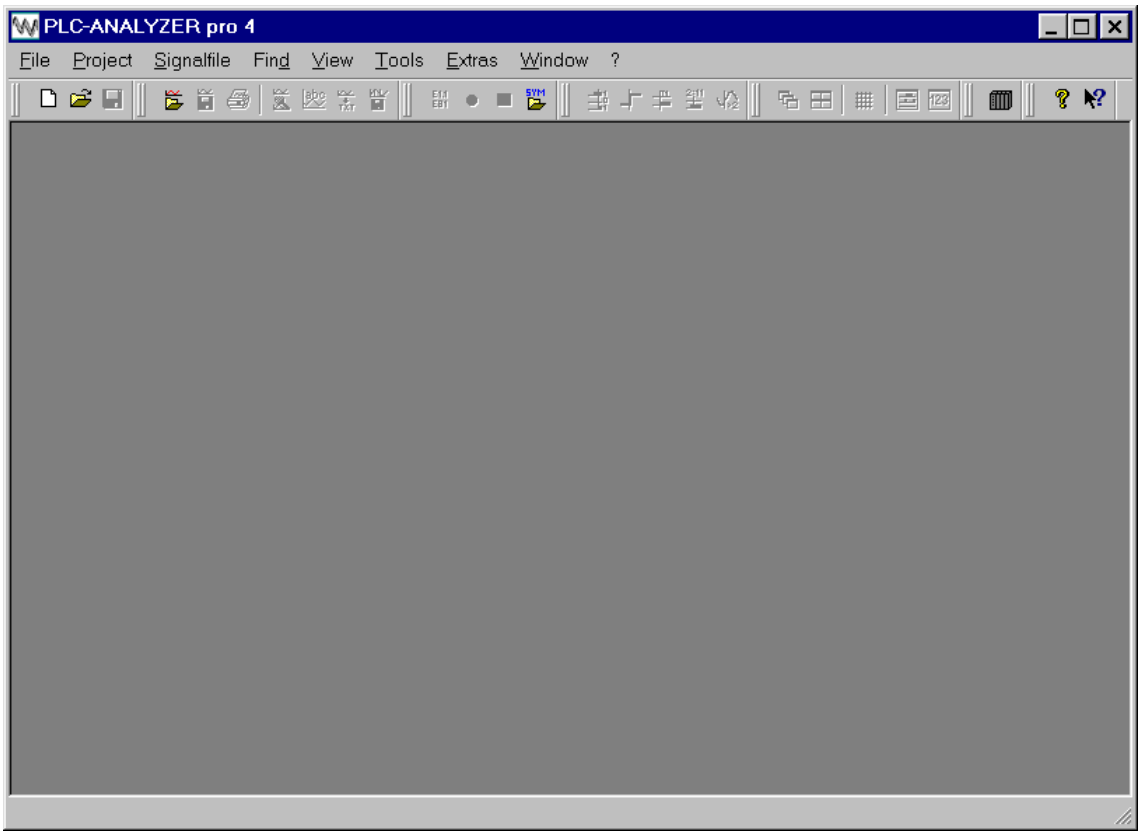


Fig. 2-1 The initial screen

If the correct key diskette was properly inserted, your screen should appear as in the above figure. Otherwise you will see a message window with the request to insert the correct key diskette.

After you have successfully installed PLC-ANALYZER pro, you should make several appropriate basic settings in the program. How to do this is described in the following chapter.

3 Configuration

Before you can acquire and analyze data, you must configure PLC-ANALYZER pro. You can select the correct driver for your PLC, select symbol files, etc. The options you set are automatically saved. During installation the program was already pre-configured according to your specifications.

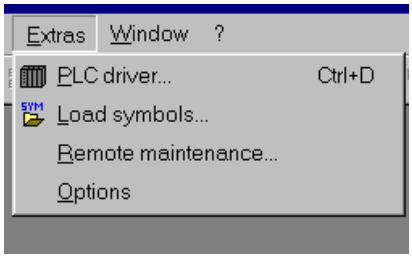


Fig. 3-1 Option menu

The menu item *Extras* is used to change the general settings.

The options set are saved when exiting PLC-ANALYZER pro. The options saved are automatically set when the program starts again.

NOTE

All options are also saved in the project files.

3.1 PLC driver

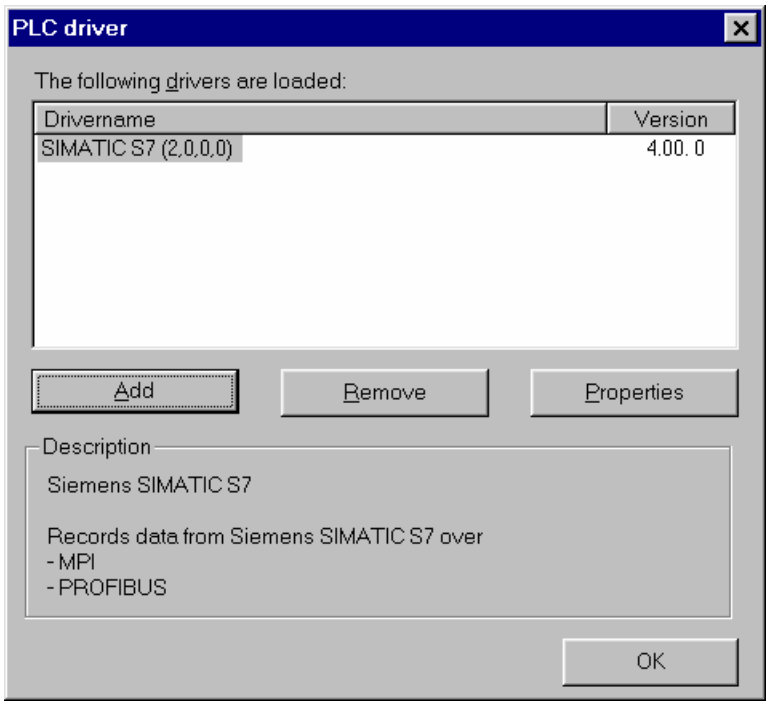


Fig. 3-2 Configuring the PLC driver

In the window *Extras - PLC driver* the PLC drivers are listed that have already been loaded. You can select further PLC drivers with *Add* and define the necessary attributes for communication.

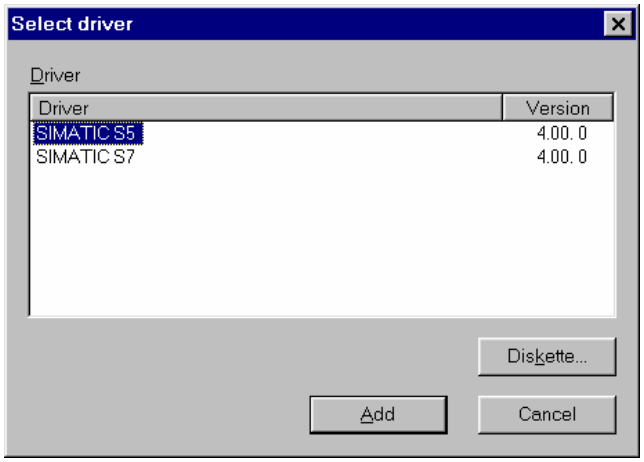


Fig. 3-3 Selecting the PLC driver

To the left you see the selection window for loading a PLC driver. All available drivers are listed. In case the driver you want is not in the list, you can click on the *Diskette...* button and install further drivers.

Select a driver and click on the *Add* button, in order to load it.

After all desired drivers have been loaded, you can set important parameters for the selected PLC driver with *Properties*. You will find a description of these parameters in the corresponding driver appendix under *Configuring the PLC driver*.

A loaded PLC driver is removed from the list of loaded drivers with *Remove*.

3.2 Load symbols

You can assign a symbol file to each loaded PLC driver. This makes possible the use of symbolic identifiers for address entry. The symbolic identifier is displayed with the absolute address and saved in a signal or project file.

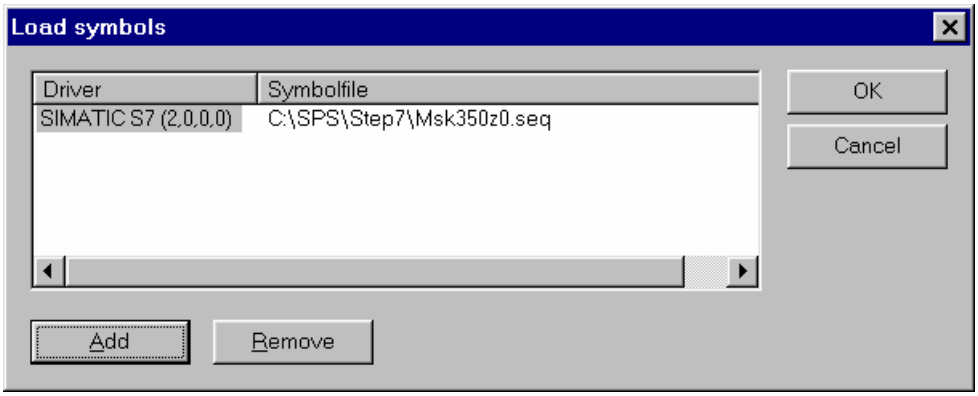


Fig. 3-4 Symbol file assignment

You select a PLC driver in the window *Load symbols* and click on the *Add* button. A file selection window appears, in which you can select a symbol file. This symbol file is assigned to the driver selected before. You can undo the connection to a symbol file with *Remove*.

NOTE

When assigning a symbol file to a S7 driver you must first convert the symbol file to the format "assignment list" (*.SEQ). In the symbol editor for STEP 7 select the menu item *Export* in the *Table* menu.

3.3 Options

Use *Options* to configure PLC-ANALYZER pro as you wish. Your configuration settings are stored and used when the program is restarted.

3.3.1 Signals

Use *Signals* to specify signal display and information according to your needs.

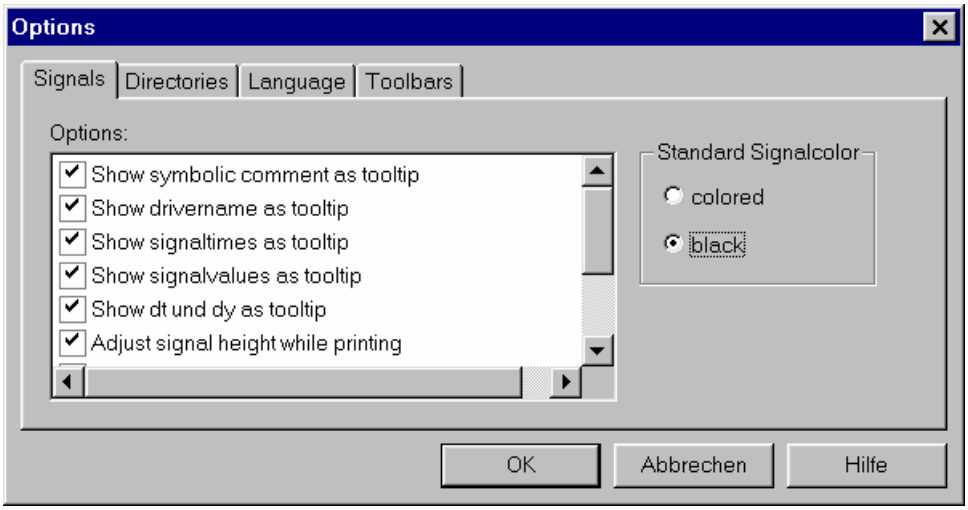


Fig. 3-1 Setting signal options

Select under *Standard Signal Color* whether signals at input should be displayed in color or monochrome. The option *colored* causes a different color to be used for every address type (input, output, flag, etc.). The option *black* causes all signals to be displayed in black. It is also possible to specify the color for a signal.

Change various signal settings under *Options*. The following options are possible:

Option	Meaning
Display symbol comment as tooltip	Displays the comment for the symbol address as text on the screen when the mouse cursor is positioned over the address in the online window.
Display driver name as tooltip	Displays the driver name of the PLC address as screen text when the mouse cursor is positioned over the address in the online window.

Option	Meaning
Display signal times as tooltip	Displays the cursor time as screen tooltip when the mouse cursor is positioned over the address in the online window.
Display signal values as tooltip	Displays the current signal value of the address as screen tooltip when the mouse cursor is positioned over the address in the online window.
Display Δt and Δy as tooltip	Displays the time and signal value difference as screen tooltip when the mouse cursor is positioned over the address in the online window.
Adjust signal height for printing	Adapts the height of the PLC signals so that all signals can be shown on one page.
Adjust signal height in online windows	Adapts the height of the PLC signals so that all signals can be displayed in one online window.
Open signal file with stored time base	Opening a signal file automatically causes the most recently stored time base to be set.
Open signal file with stored cursor position	Opening a signal file automatically causes the most recently stored cursor position to be set.
Display symbol addresses	An existing symbol name for an address is automatically displayed.

Table 3-1 Setting signal options

3.3.2 Directories

Here you specify the default directory path for saving and loading signal and project files. The program uses these directories if they are not otherwise specified.

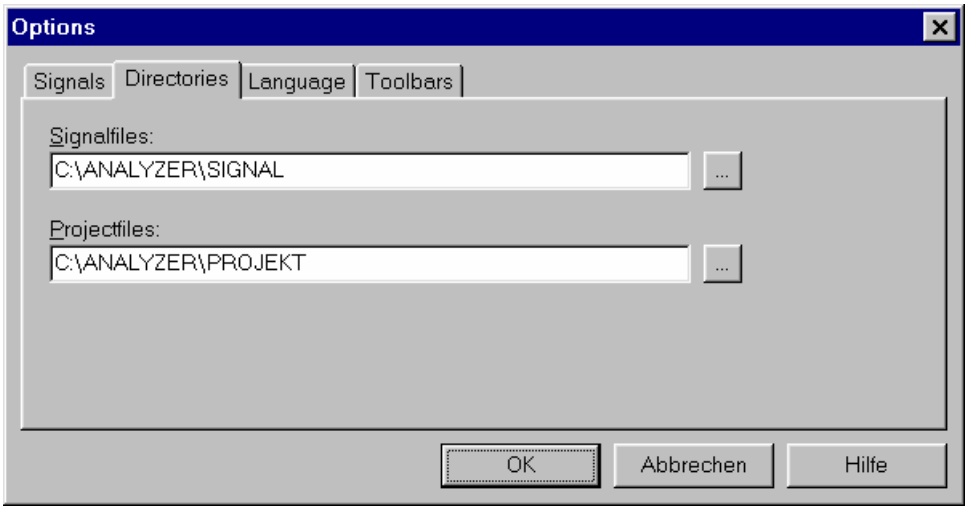


Fig. 3-5 Selecting the standard directories

You can change the directory paths by clicking on the buttons to the right of the text fields.

3.3.3 Language

You use this window to set the menu language of PLC-ANALYZER pro. Then click the *OK* button to switch to the desired language while using PLC-ANALYZER pro.

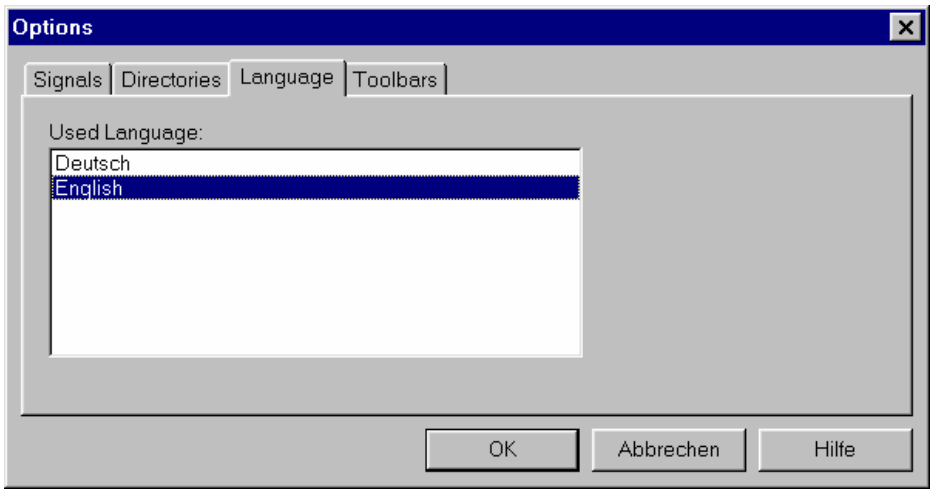


Fig. 3-2 Language selection

3.3.4 Toolbars

PLC-ANALYZER pro offers several toolbars enabling you to directly select important functions through the corresponding icons[3]. You can configure the toolbars according to your needs on the *Toolbars* tab page.

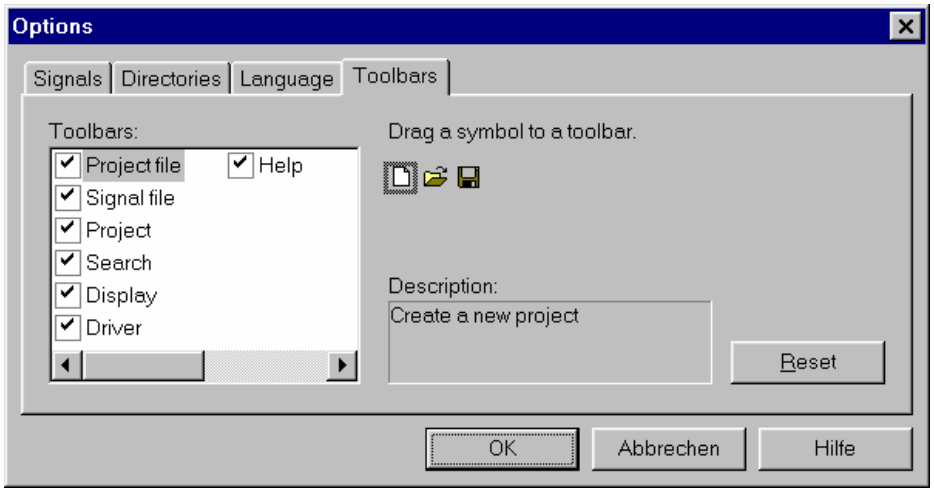


Fig. 3-3 Configuring toolbars

The available toolbars are listed under *Toolbars*. Activate the check box next to the corresponding name in order to make the toolbar visible.

You can move individual commands from the selected toolbar to another toolbar simply by dragging the desired symbol with the mouse onto the corresponding toolbar in the PLC-ANAYLZER pro main window.

[3] Icon = small symbolic graphic.

Use *Reset* to reestablish the original state of the selected toolbar.

The following table describes the toolbar icons:

Button	Meaning
	Creates a new project. Any project still open is closed
	Loads a project. Any project still open is closed
	Stores the current project
	Loads a signal file
	Stores the active signal file under its current name
	Exports the current signal file as graphic or text
	Compares two signal files with each other
	Inserts text into the online window
	Stores the selected range of the active signal file
	Prints the signal file of the active online window
	Starts signal recording in the current project
	Stops signal recording in the current project
	Opens the *Project settings* window
	Opens the *Bit pattern search* window
	Opens the *Signal-edge search* window
	Opens the *Analog value search* window
	Opens the *Trigger search* window
	Opens the *Time search* window
	Displays all open online windows as overlapping
	Displays all open online windows as contiguous
	Toggles the grid on/off in the active online window
	Graphical display of the signals
	Signal display in text mode
	Loads a PLC driver and the corresponding settings
	Opens the *Load symbols* window
	Opens the *Info* window with information on PLC-ANALYZER pro 4
	Starts context-sensitive Help. Click this button and then select a menu item or a toolbar button in order to display a corresponding help text.

Table 3-2 Toolbar icons

3.4 Remote maintenance

You use the *Remote maintenance* window to set the required parameters for recording PLC signals over the telephone line.

Activation of remote maintenance is only possible if the remote maintenance software terraLink® from the AUTEM company has already been installed (see *section 6.1 Remote diagnosis with terraLink®*).

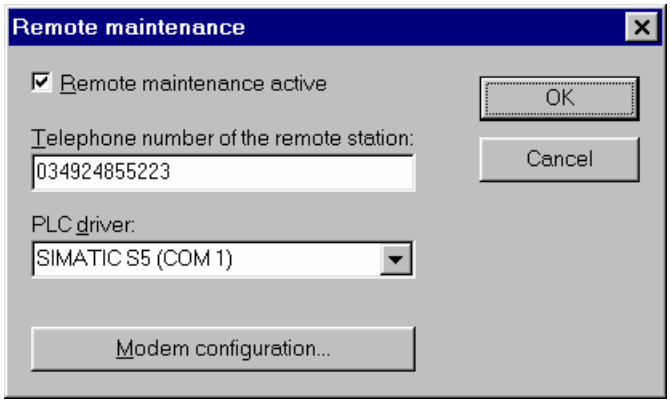


Fig. 3-4 Configuring remote maintenance

Activate remote maintenance by checking the control field *Remote maintenance active*. Enter the telephone number of the remote modem under *Telephone number of the remote station*. This number will be automatically called when recording begins.

Select under *PLC driver* a driver appropriate for the remote PLC. If the drop-down selection list contains no appropriate driver, then you must load a driver (see *section 3.1 PLC driver*).

Click the *Modem configuration...* button to display the terraLink® configuration window. There you can specify initial settings and initialize the modems.

3.5 Tools

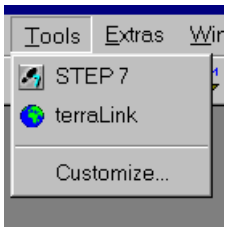


Fig. 3-5 Tools menu

The *Tools* menu can be used to start external programs from PLC-ANALYZER pro. Any program can be selected and modified at any time using *Customize...*. Clicking on an existing menu item causes the corresponding program to be called from PLC-ANALYZER pro.

4 Data acquisition

This chapter describes how to acquire data from a PLC.

Start the project assistant with *Assistant 'New project'* in the *File* menu. The project assistant leads you step-by-step to a new project. On the first page of the assistant you give the project an appropriate name with eventual descriptive comments. Move to the next page with *Continue*. On each page enter the data appropriate to your new project.

The menu item *New project*... in the file menu offers another possibility in defining a project. In the *Create new project* window you give the project an appropriate name with eventual descriptive comments. Go to project settings with *Continue*.

Every acquisition of signal data is controlled by PLC-ANALYZER pro with a so-called project. You should create a new project with *New project*... in the *File* menu.

You define a new project in the *Create new project* window. Give the project a meaningful name and perhaps also descriptive comments. You arrive at project settings by clicking on *Continue*.

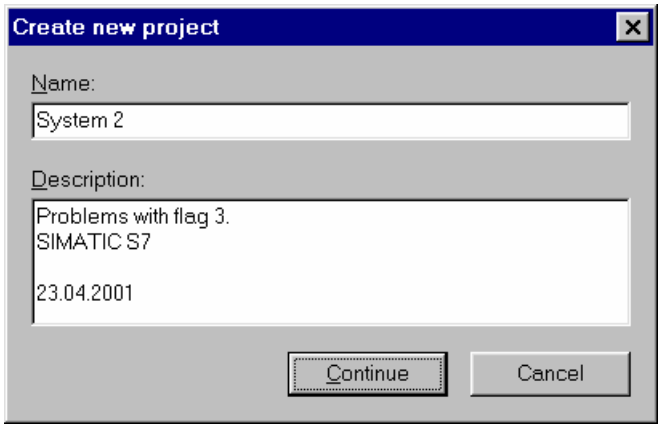


Fig. 4-1 Definition of a new project

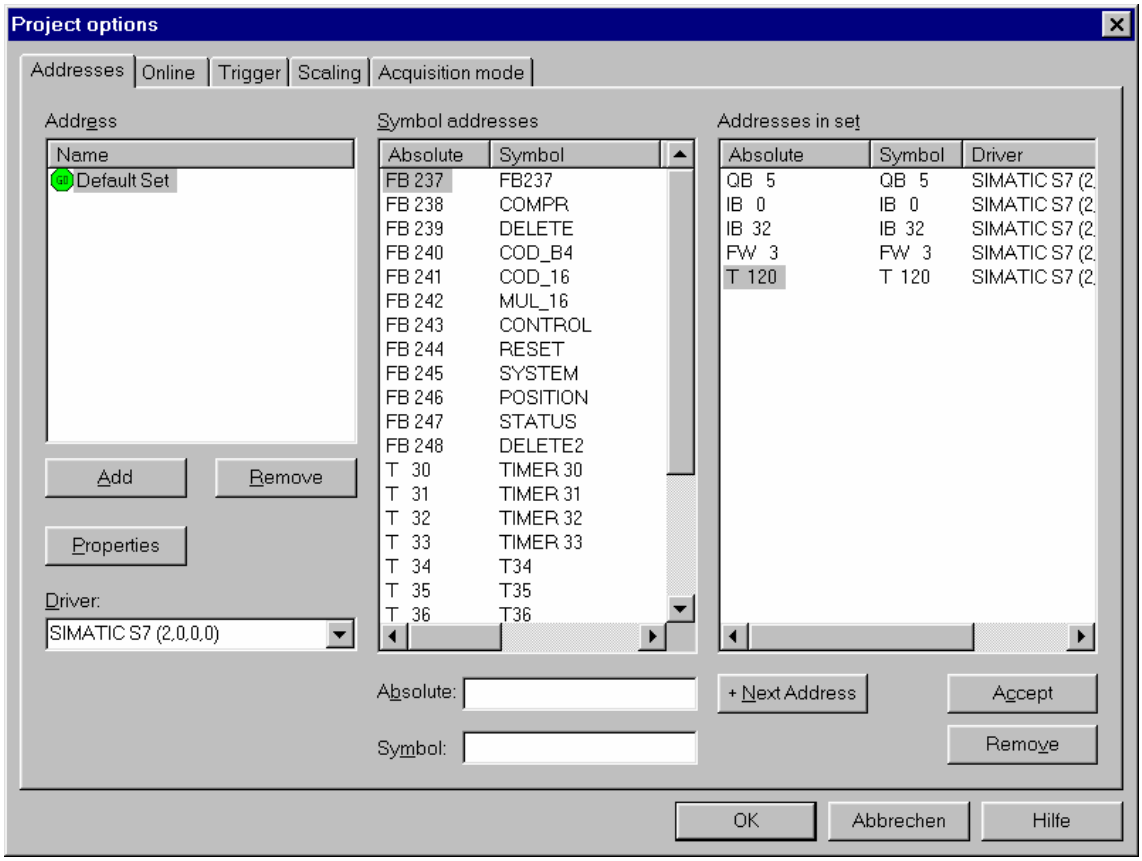


Fig. 4-2 Entering signals to acquire

4.1 Address selection

In the *Addresses* window you specify which signal you want to record. First, select the PLC driver under driver for the desired address. Then enter the desired addresses sequentially into the text field *Absolute* according to the syntax of the PLC driver. Clicking on the Accept button or pressing ENTER causes the entered address to be included in the *Addresses in set* list. If several addresses should be recorded in sequence (e.g. EB0, EB1, EB2 ...), then click on the *Next address* button. With *Remove* you delete the signal addresses that should not continue to be recorded.

NOTE

The simultaneous acquisition of signals from different PLC controllers with several drivers is possible. Simply load all necessary drivers and make sure that the correct driver has been selected for each address.

The following table shows as an example the address syntax for the Siemens SIMATIC S7 family.

Syntax	Address type	Example
Qx.z	Output byte x, bit z	Q32.4
QBx	Output byte x	QB9
QWx	Output word x	QW14
QDx	Output double word x	QD98
Ix.z	Input byte x, bit z	I17.0
IBx	Input byte x	IB127
IWx	Input word x	IW12
IDx	Input double word x	ID124
Fx.z	Flag byte x, bit z	F3.7
FBx	Flag byte x	FB250
FWx	Flag word x	FW24
FDx	Flag double word x	FD134
FGx	Flag x (floating-point representation)	FG104
Tx	Timer x	T2
Cx	Counter x	C5
DByDBXx.z	Data byte x, bit z from data block y	DB23DBX2.5
DByDBBx	Data byte x from data block y	DB2DBB5
DByDBWx	Data word x from data block y	DB12DBW5
DByDBDx	Data double word x from data block y	DB27DBD0
DByDBGx	Data x from data block y (floating-point)	DB2DBG54

Table 4-1 Address syntax SIMATIC S7

Please consult the appropriate driver appendix for the address syntax of other PLC systems.

With PLC-ANALYZER pro you can use the symbol files created by the programming software. Specify the desired symbol file under *Extras - Load symbols*. When a symbol file is loaded all symbolic identifiers of the symbol file are displayed in the *Symbol address* list. You can now enter symbolic addresses in the *Symbol* text filed or double-click on a symbol address to select the address for acquisition.

NOTE

Some programmable controllers (e.g. SIMATIC S7) only allow bytewise data acquisition. In such a case PLC-ANALYZER pro converts a given bit address automatically into a byte address. All bits are available for display.

PLC-ANALYZER pro enables you to define several address groups - so-called address sets. You can assign signals to each address set. You create a new address set with *Add*.

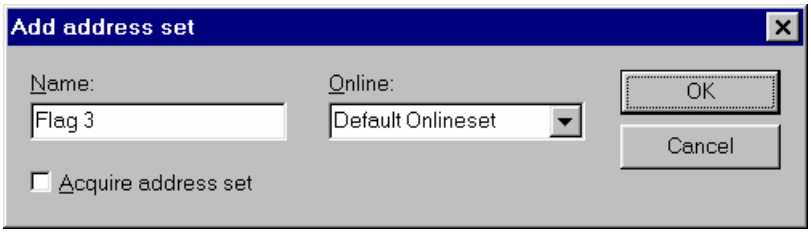


Fig. 4-3 Define address set

Give the address set a name and select the online window, in which the given addresses should be displayed. Use the control field *Acquire address set* to specify whether the address set signals should be acquired. With OK the address set is included in the list of *Address sets*.

You can change the settings of already defined sets with *Properties*. Use *Remove* to delete the selected address set.

4.2 Online signal selection

A particular feature of PLC-ANALYZER pro is the online display of recorded values in a fashion similar to an oscilloscope. In the *Online* window you can select the current signal to be displayed.

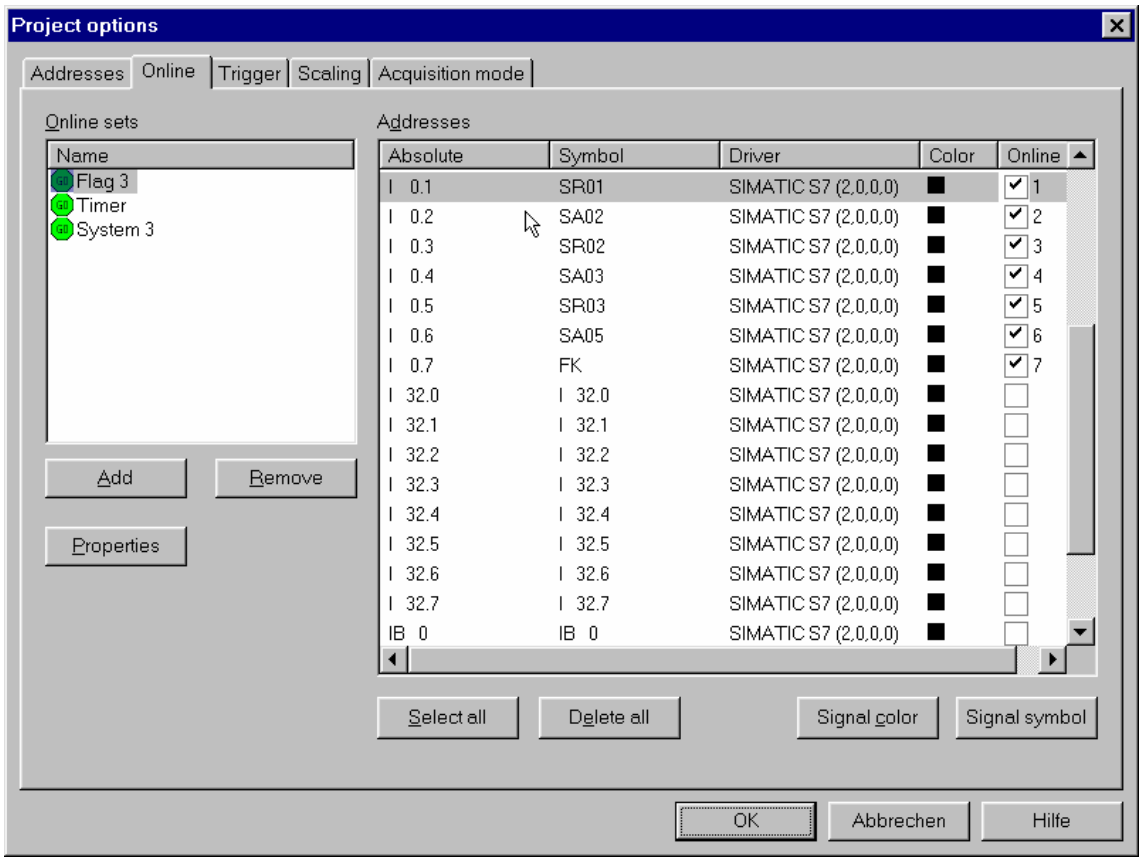


Fig. 4-4 Selecting signals for online display

The signals are selected with the mouse or the keyboard. For keyboard use the signal is selected with <ENTER>. Use the mouse to select a signal by checking the check box in the online column. A selected signal is given a number indicating its sequence position during display. You can change an existing sequence number by double-clicking on the corresponding number in the online column and entering a new position. A selected signal is given a number indicating the display sequence. In this way you can make sure that signals logically related are displayed next to each other. Signals already selected can be deselected from online display simply by being selected again.

Use the *Signal symbol* button to change the symbol name and the comments on a selected signal.

Use the *Signal color* button to change the color of the signal in the online window. The *Select all* button automatically selects all signals. The entire selection is deleted with *Delete all*.

You can define several groups of addresses for online display - so-called online sets. Each selected group is assigned to an online window. Clicking on the *Add* button causes a new online set to be created.

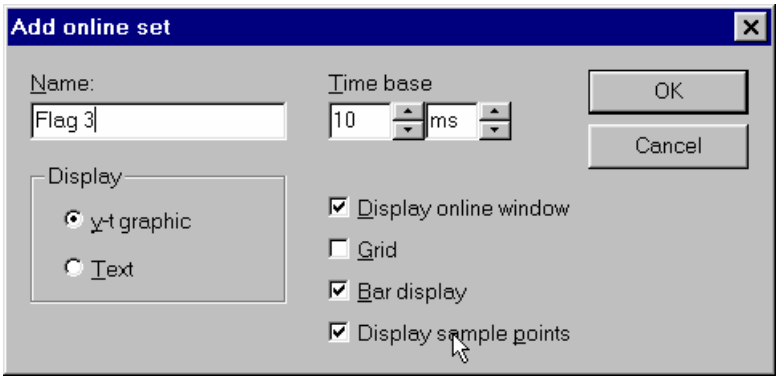


Fig. 4-5 Define new online selection

You can set various parameters for a new online set in the *Add online set* window. Give the set a name and under *Display* select the type of display in the online window.

The time base gives the time per screen pixel. Setup takes place under *Time base*. This can also be changed during acquisition.

With the control field *Display online window* you indicate whether the online set is displayed as online window during acquisition.

Activating the control field *Raster* causes a raster grid to appear in the display area of the online window. With *Bar display* you indicate whether discrete signals (binary signals) are displayed as solid bars. Normally, these are displayed as lines.

Under *Display sample points* you activate display of sample points, which are then displayed as small points on the signal curve. The sample interval can be set in the window *Properties* of the PLC driver. More information on this can be found in the driver appendix for the corresponding PLC driver.

With *OK* you accept the entered parameters, and the new online set is displayed in the list.

You can change attributes of already defined online sets with *Properties*. You delete a selected online set with *Remove*.

4.3 Trigger

PLC-ANALYZER pro allows you to trigger recording upon occurrence of certain events, e.g. sporadically occurring errors. With this feature you can create signal files containing a specific event with the signal history leading up to and following the event.

You can trigger on binary and analog signals. For binary signals you can trigger on either logical "0" or "1". For analog signals you can trigger on the relations greater than (>), less than (<), equal (=), and not equal (< >).

Trigger conditions can be combined with the logical operators AND and OR, enabling you to specify complex trigger conditions.

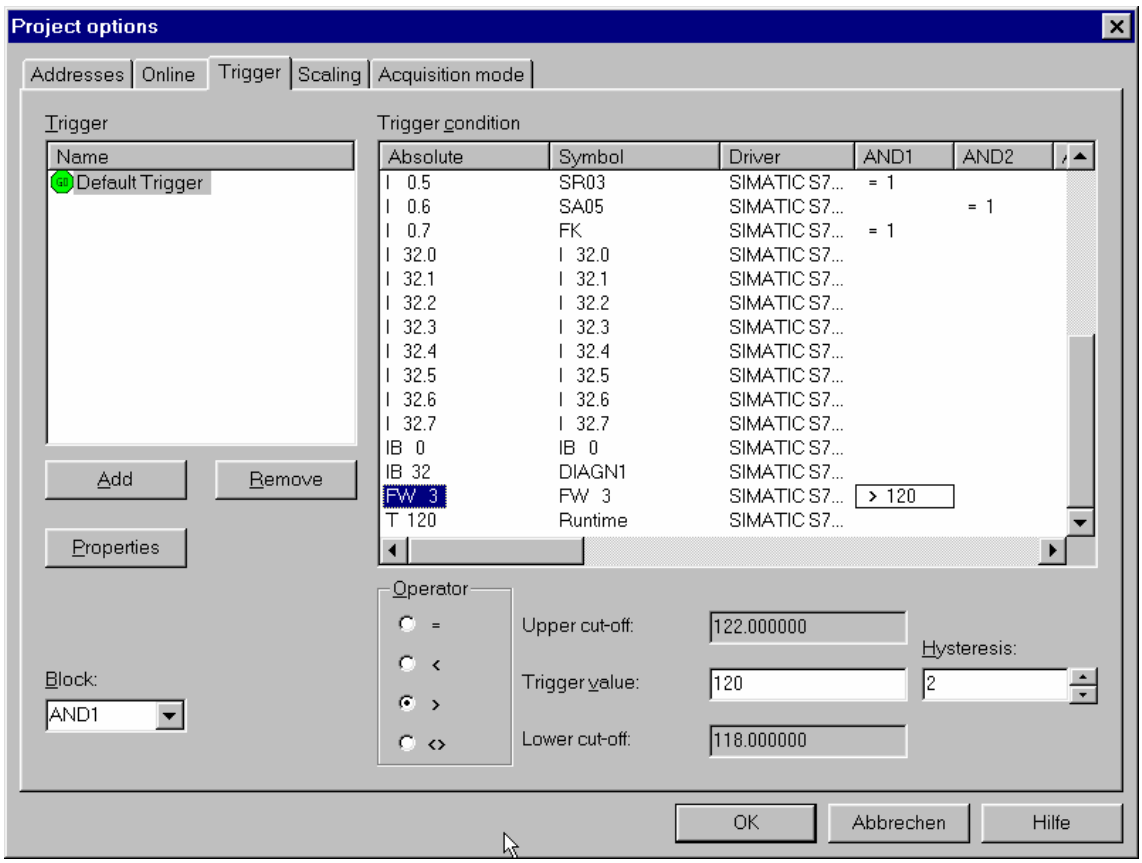


Fig. 4-6 Entering trigger conditions

In the *Trigger* window the signals available for triggering are listed in the table *Addresses*.

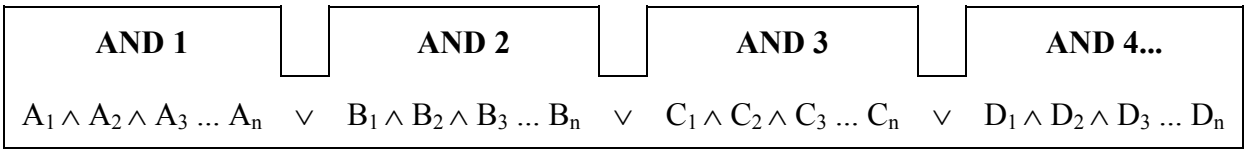
You can define several triggers. A new trigger is created when you click on the *Add* button. The settings for this trigger are explained in more detail in *section 4.3.4 Setting trigger properties*. You can modify or delete an existing trigger with *Properties* and *Remove*.

4.3.1 Trigger on binary signals

Move with the mouse or arrow keys to the desired binary value address. Type 0 or 1 at the keyboard. The trigger condition appears in the *Trigger condition* list. You can delete the condition by pressing <Del>.

4.3.2 AND / OR combination of trigger signals

In order to specify complex trigger conditions PLC-ANALYZER pro allows you to combine individual conditions with the logical AND and OR operations. There are up to 20 AND blocks which are combined with logical OR. The individual conditions within each block are combined with logical AND.


AND 1
AND 2
AND 3
AND 4...
$A_1 \wedge A_2 \wedge A_3 \ldots A_n \vee B_1 \wedge B_2 \wedge B_3 \ldots B_n \vee C_1 \wedge C_2 \wedge C_3 \ldots C_n \vee D_1 \wedge D_2 \wedge D_3 \ldots D_n$

Select under *Block* the block in which you would like to insert the new condition. Alternatively, you can select from the list *Trigger condition* a field in one of the AND columns. You can do this with mouse or keyboard. The active address, for which you can enter a trigger condition, is highlighted within a frame in the current AND block. An address can be used in each block only once. The current trigger condition is displayed in the list *Trigger condition*.

4.3.3 Trigger on analog signals

Move with the mouse or arrow keys to the desired analog value address. Select one of the four comparison operators under Operator. Then enter the corresponding number value under *Triggering value*.

The hysteresis can be set in order to prevent trigger-bouncing resulting from small fluctuations. The hysteresis value is selected under *Hysteresis*. The program determines the *upper cut-off* and *lower cut-off* automatically according to the entered hysteresis value. When triggering on equal (=) or unequal (≠) the entered hysteresis is used as the unsharpness value.

The following table explains how the various trigger operators function:

Trigger operator	Description
<	Triggering occurs if the trigger value is exceeded. Triggering can occur again only if the signal falls below the lower cut-off value.
>	Triggering occurs if the signal falls below the trigger value. Triggering can occur again only if the signal exceeds the upper cut-off value.
=	Triggering occurs if the measured value lies in the range between the lower and upper cut-off values. Triggering can occur again only if the signal goes outside the range.
<>	Triggering occurs if the measured value leaves the range between the lower and upper cut-off values. Triggering can occur again only if the signal enters the range.

Table 4-2 Trigger operator

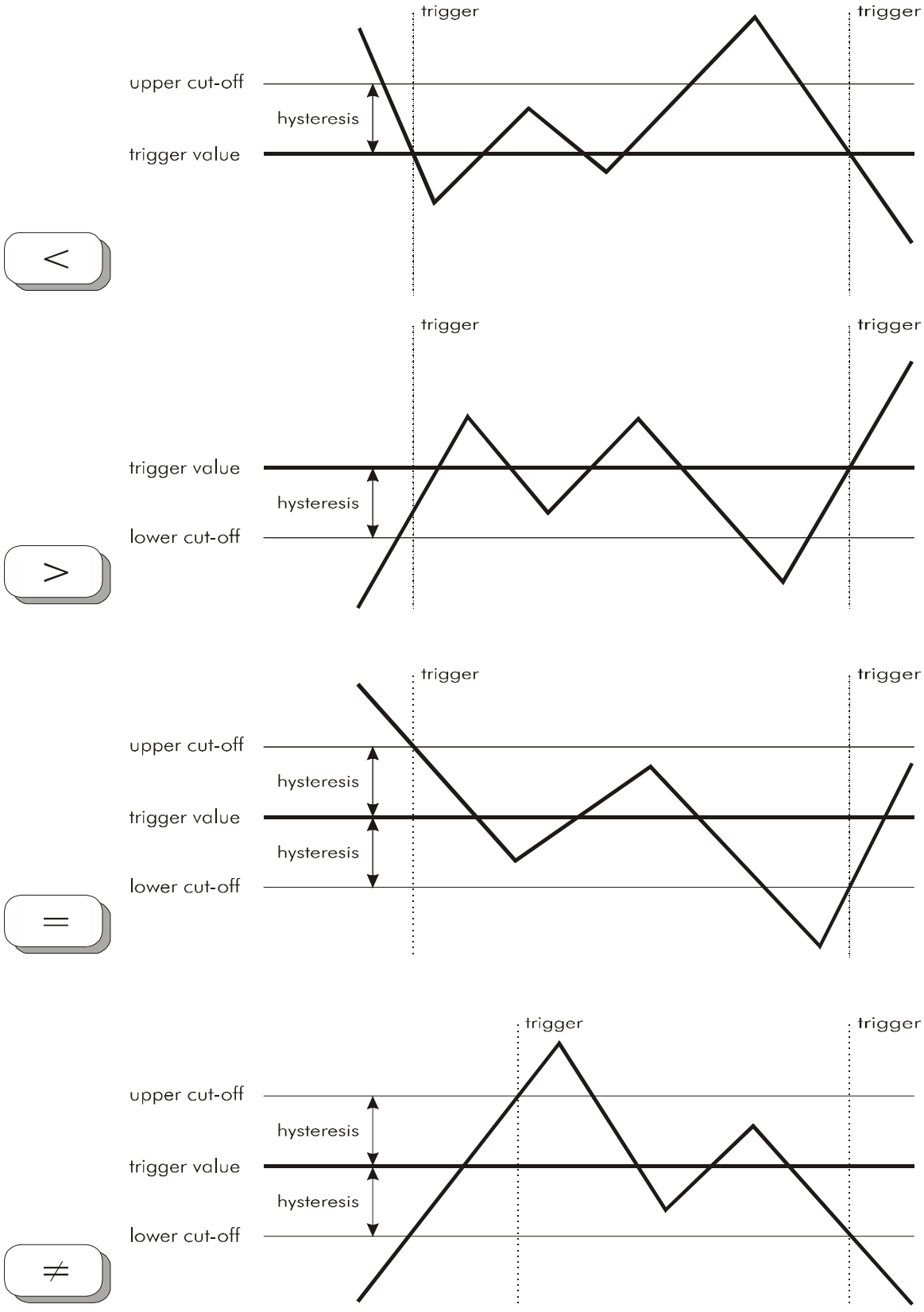


Fig. 4-7 Principles of analog triggering (< , > , = , <>)

4.3.4 Setting trigger properties

You modify trigger properties with *Properties* in the *Trigger* window.

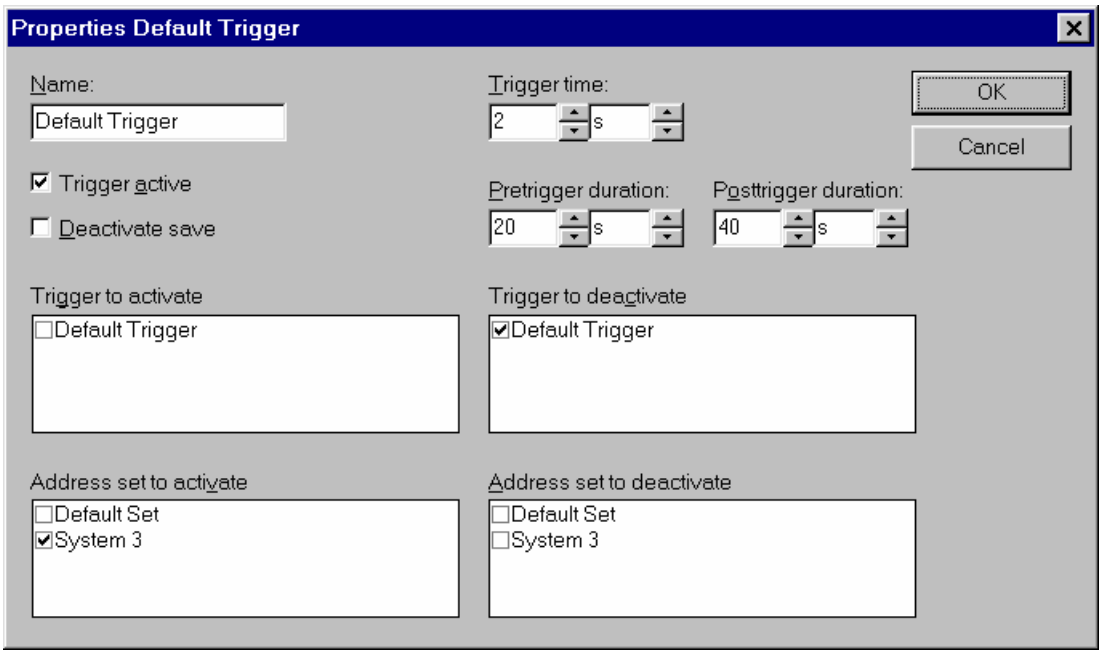


Fig. 4-8 Setting trigger properties

You give the trigger a name in the Properties window and activate it with the help of the control field *Trigger active*. If the trigger is deactivated, then even satisfied trigger conditions will not cause the trigger to fire.

The *Trigger time* of the trigger indicates how long the trigger condition must be fulfilled before the trigger fires.

With PLC-ANALYZER a fired trigger can activate or deactivate a trigger address set and triggers. The lists *Address set to activate* and *Address set to deactivate* display the address sets that were defined before in the *Address selection* window. Selecting the control field in front of an address set causes the corresponding set to be selected. If a trigger fires during signal acquisition, the selected address sets in the lists are activated (or deactivated). After the trigger has fired the addresses in the active address sets are monitored. Monitoring of deactivated sets is stopped. Triggers can be activated and deactivated in the same way by selection in the lists *Triggers to activate* and *Triggers to deactivate*.

During trigger-controlled recording (see *section 4.5 Modes of data acquisition*) the PLC signals fulfilling the trigger condition are saved in a signal file. Under *Pretrigger duration* you specify the length of time before the trigger event for which signals are saved. *Posttrigger duration* indicates for how long signals should be saved after the trigger event.

The control field *Deactivate save* is used to prevent saving of PLC signals during a trigger-controlled recording. This is meaningful when you simply want to use a trigger to activate/deactivate address sets or other triggers.

4.4 Scaling of register values

With the help of online scaling you can influence the display of analog values in respect to their number value and the graphical representation. For example, you can convert signal values to physical units (m, kg ...) and display them correspondingly on the screen. You can specify unit, factor, and offset of an analog value. The analog signal is converted according to the following formula:

Display value = Factor • Measured value + Offset

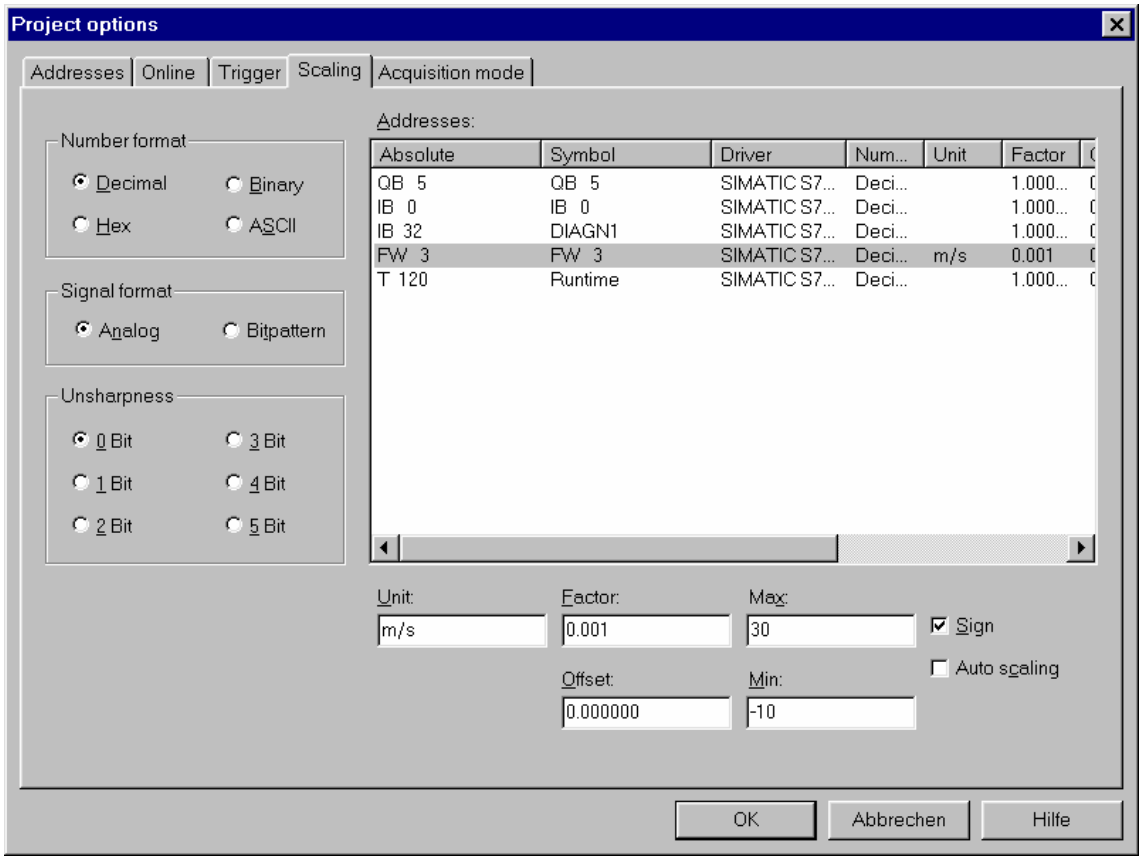


Fig. 4-9 Register scaling for online display

Select the signal to be scaled and change if necessary the default values in the corresponding text boxes. Under *Sign* select whether the measured value should be interpreted as signed (two's complement) or unsigned.

Under *Number format* you change the format of the selected measured value. The measured value can be displayed not only with *Decimal* and *Binary*, but also as a pure hexadecimal value ($00000000...$FFFFFFFF) and as an ASCII character.

If you are interested in seeing the bit pattern for a particular measured value, then under *Signal format* switch to *Bit pattern*. PLC-ANALYZER pro then displays the signal as bit pattern.

In order to reduce the amount of recorded data for lightly fluctuating analog values, you can set the *Unsharpness* from 1 to 5 bits. Variation of measured values in these bits is then simply ignored.

PLC-ANALYZER pro can automatically adapt the vertical scale of an analog signal, so-called *Auto scaling*. The signal is scaled in such a way that the maximum value lies at the upper end of the scale and the minimum value at the lower end. Automatic scaling is preset as default.

If you desire fixed scaling of the displayed values, then you can switch off the *Automatic scaling* check box. Now you can manually enter the scaling limits for the display under *Min* and *Max*. Entry takes place according to the format set under *Number format*.

Fixed scaling is useful, for example, if you would like to "zoom" small changes of a measured value in a particular value range. Please note that changing the sign interpretation may cause the minimum and maximum values to be reversed.

4.5 Modes of data acquisition

Four different types of acquisition are available. You specify the type of data acquisition under *Acquisition mode*.

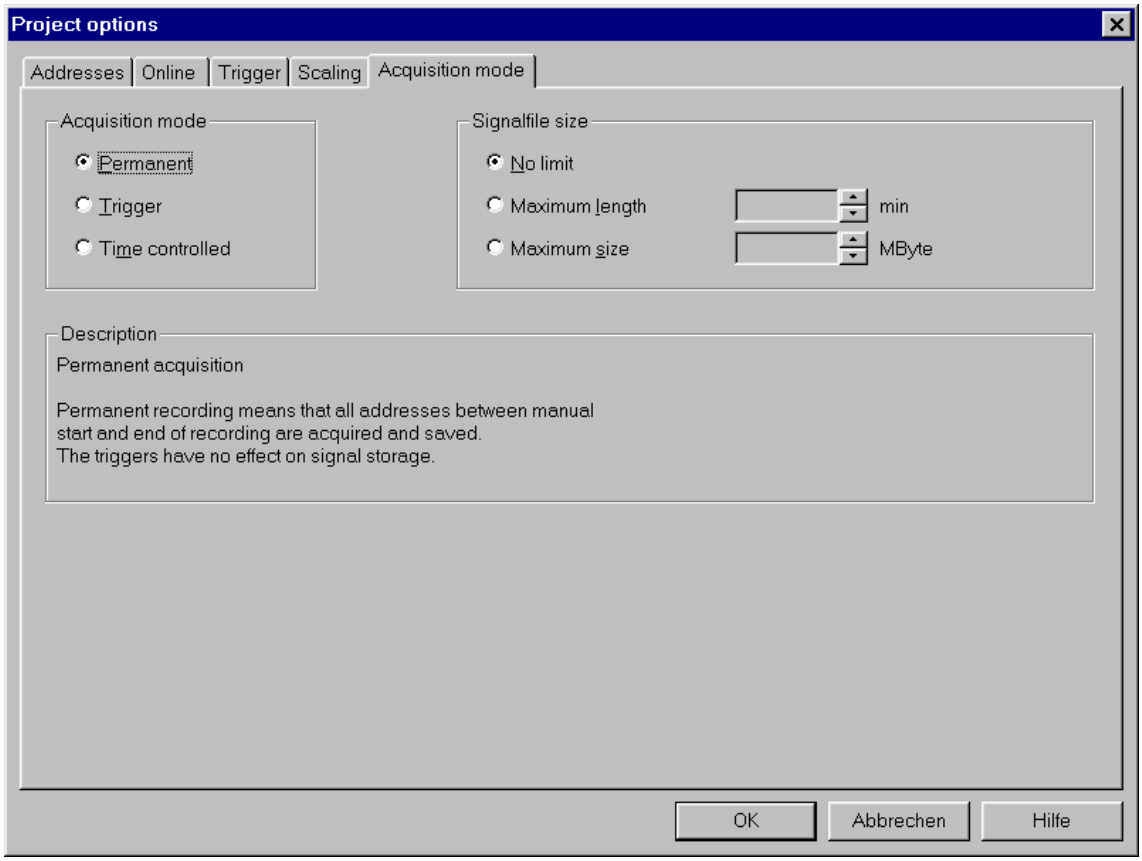


Fig. 4-10 Setting the acquisition mode

The signal data acquired by the PLC are saved in a signal file according to the acquisition mode.

Acquisition mode	Description
Permanent	The selected PLC signals are recorded from manual start to end without breaks. Under *Signal-file size* you can limit the size of the signal file. If the limit is reached, then the current signal file is saved and a new signal file automatically created.
Trigger	Depending on the trigger times set (*see section 4.3.4 Setting trigger properties*) the measured values are saved in a signal file upon trigger occurrence.
Time controlled	When acquisition starts, you are requested to specify the start and stop time for the recording. The selected PLC signals are recorded between these points in time. Recording stops when the stop time is reached.

Table 4-3 Modes of data acquisition

4.5.1 Cycle-precise acquisition

In addition to the acquisition modes already explained some PLC drivers allow cycle-precise data acquisition. Selected signals within the PLC are pre-acquired cycle-precise. More detailed information can be found in the corresponding driver appendix.

4.6 Starting data acquisition

Make sure that the data acquisition attributes have been correctly set. Exit the *Recording* window only by clicking on the *OK* button. The online windows you have defined appear on the screen. Save your project with *Save project* in the *File* menu so it can be used again later. If you want to modify your project again, select the menu item *Project settings...* in the *Project* menu.

Start acquisition with *Start acquisition* in the *Project* menu. PLC-ANALYZER pro carries out a communication test with the automation device first, in order to test the connection and to determine any particularities of the connected PLC driver or its CPU.

If the communication test fails, you are notified with the message "Error during connection attempt". In this case, check the settings of the PLC driver under *Options - PLC driver* for correctness and hardware connection to the PLC (see driver appendix).

After successful connection PLC-ANALYZER pro records the selected PLC signal data and creates - depending on the acquisition mode - one or more signal files.

If you have selected online signals, then these are displayed on the screen either in an oscilloscope-like manner or in text form. Otherwise the signal display area of the screen remains empty. For online display the left column shows the address identifier in absolute or symbolical form. In the right column the currently measured values are displayed. Occurring triggers are displayed immediately as vertical dashed lines on the screen.

The time base can be changed during acquisition.

Signals and their scaling can be changed when data acquisition is running. To do this, select the menu item *Project – Project settings*. Data acquisition is not interrupted, however. The settings are stored in the signal file being recorded.

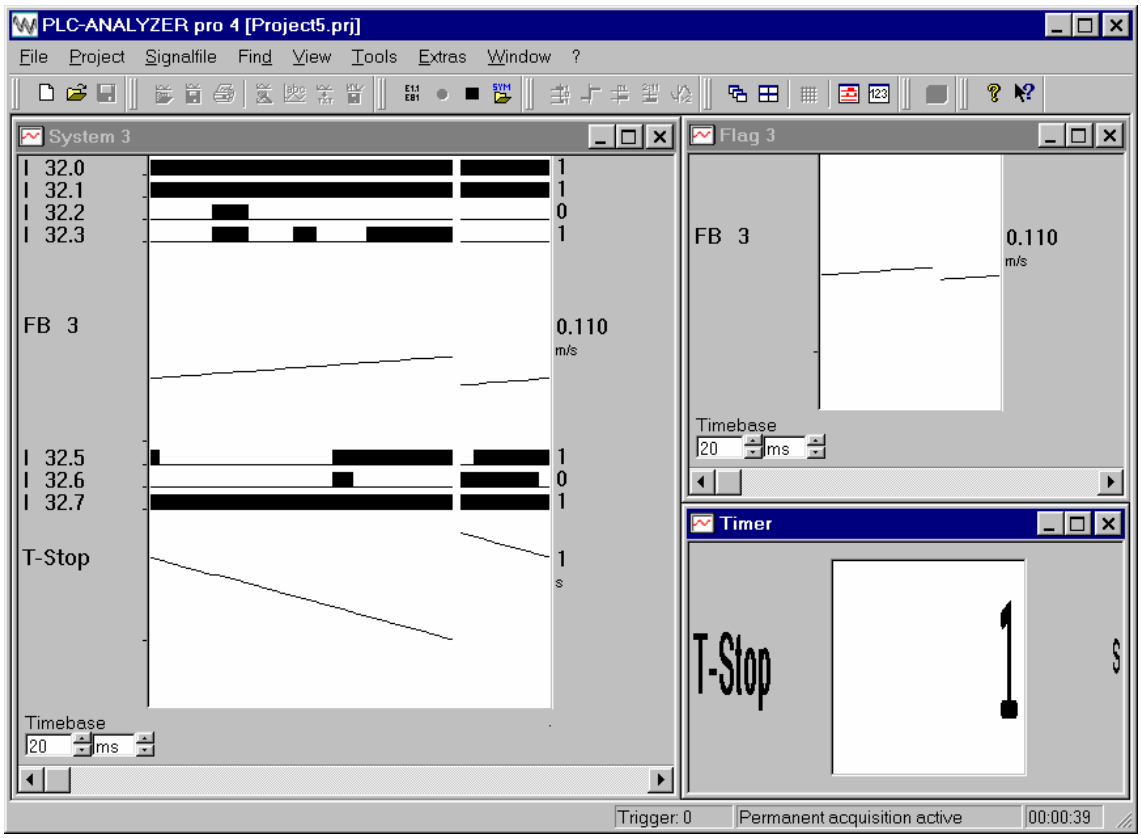


Fig. 4-11 Signal acquisition with graphics and text online window

NOTE

An analog signal is displayed in gray if the signal falls outside the range of the scaling limits. With automatic scaling the scale is corrected after every pass of the signal over the screen.

Communications trouble also causes the signal color to change to gray. In this case the current values are not displayed.

The name of a signal file is dependent on the time of the first recorded PLC signal entry. The name is made up of day, month, year, hour, minute, and second, plus extension ".SPS ", e.g. `13.04.2001 124523.SPS` (created on 13 April 2001 at 12.[45] and 23 seconds).

Acquisition is terminated by selecting the menu item *Project - Stop acquisition*.

After ending acquisition the last signal file created is automatically opened. The time base is automatically chosen so that the entire recorded signal is visible in the online window.

5 Signal display and analysis

The evaluation of recorded signal data is described in this chapter. Diverse tools are available for detailed analysis, e.g. time measurement and diverse search functions.

5.1 Opening a signal file

After the end of data acquisition PLC-ANALYZER pro always automatically loads the last signal file created.

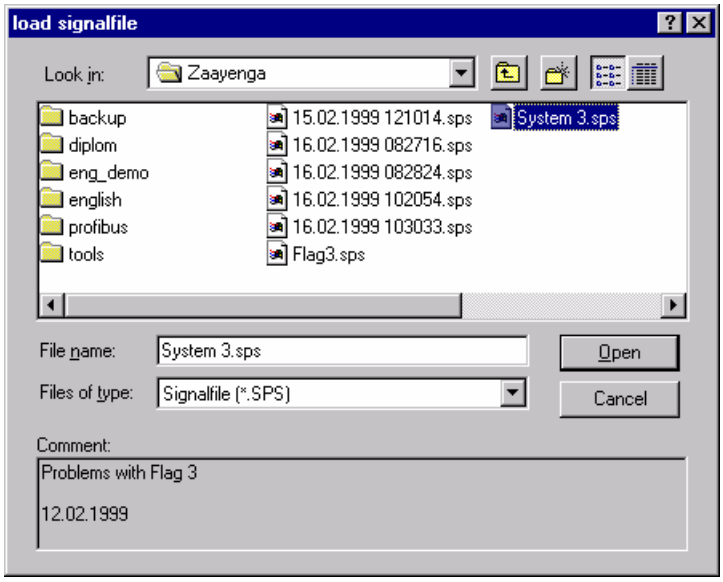


Fig. 5-1 Opening a signal file

You can also open a signal file in the *File* menu either with the History list (contains the four most recently loaded signal files) or with *Open signal file...*

The signal files are listed alphabetically in the file selection window; this does not necessarily correspond to the recording sequence in time. Comments with notes on the contents of a signal file are displayed in the bottom portion of the window.

To open a signal file select it and then simply click on the *Open* button.

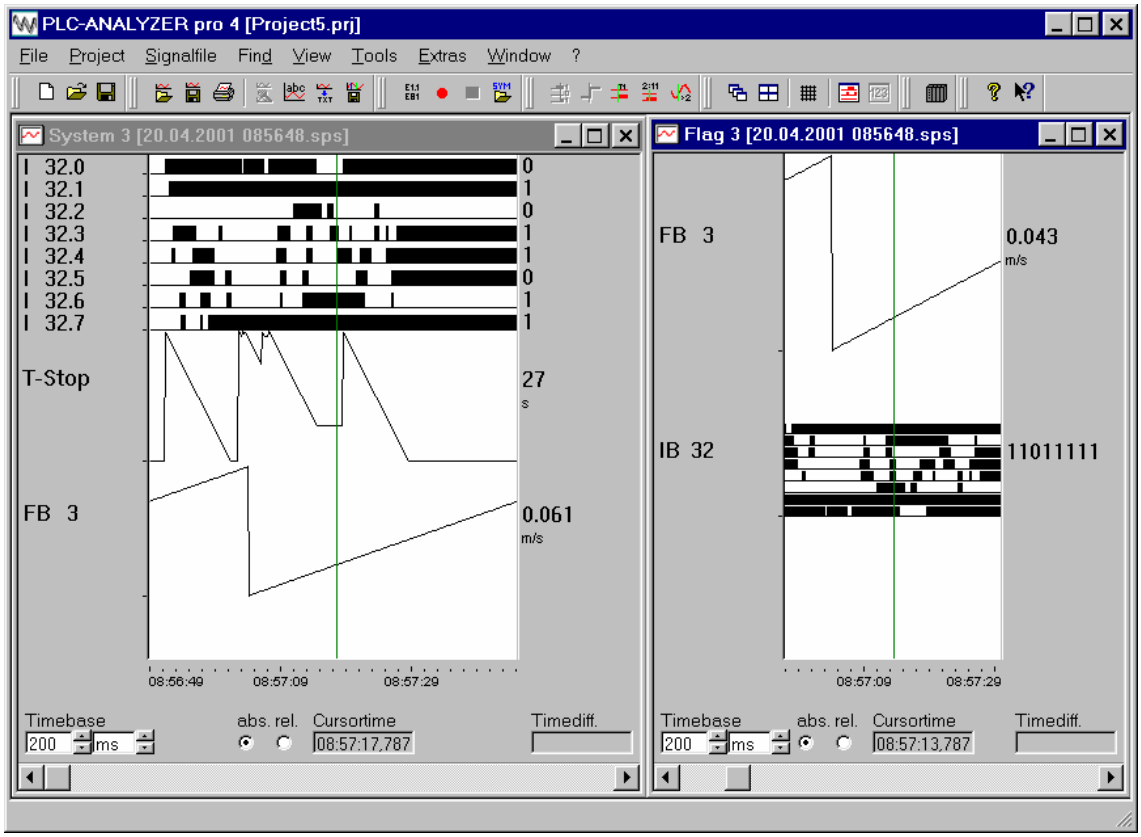


Fig. 5-2 Signal file display

The name of the opened signal file is displayed in the title bar of the signal window. You can have several signal files opened simultaneously, so that a direct comparison is possible.

A signal window is opened with the signal selection and scaling contained in the signal file. In a signal window the left side displays the address identifiers of the displayed signals in absolute or symbolic form. The right side shows the signal values at the current cursor position.

The time base for the display is always chosen so that the contents of the entire file fit in the signal window. For a detailed analysis it is meaningful to set an appropriate time base (see *section 5.5.2 Setting the time base*).

5.2 Signal selection

When a signal file is opened the PLC signals are displayed according to the online selection in the signal file. If you wish to change the signal selection then click on menu item *Selection* in menu *Signal file*. Alternatively, you can click the right mouse button in the display area of the signal window and then choose the Selection menu item in the context menu.

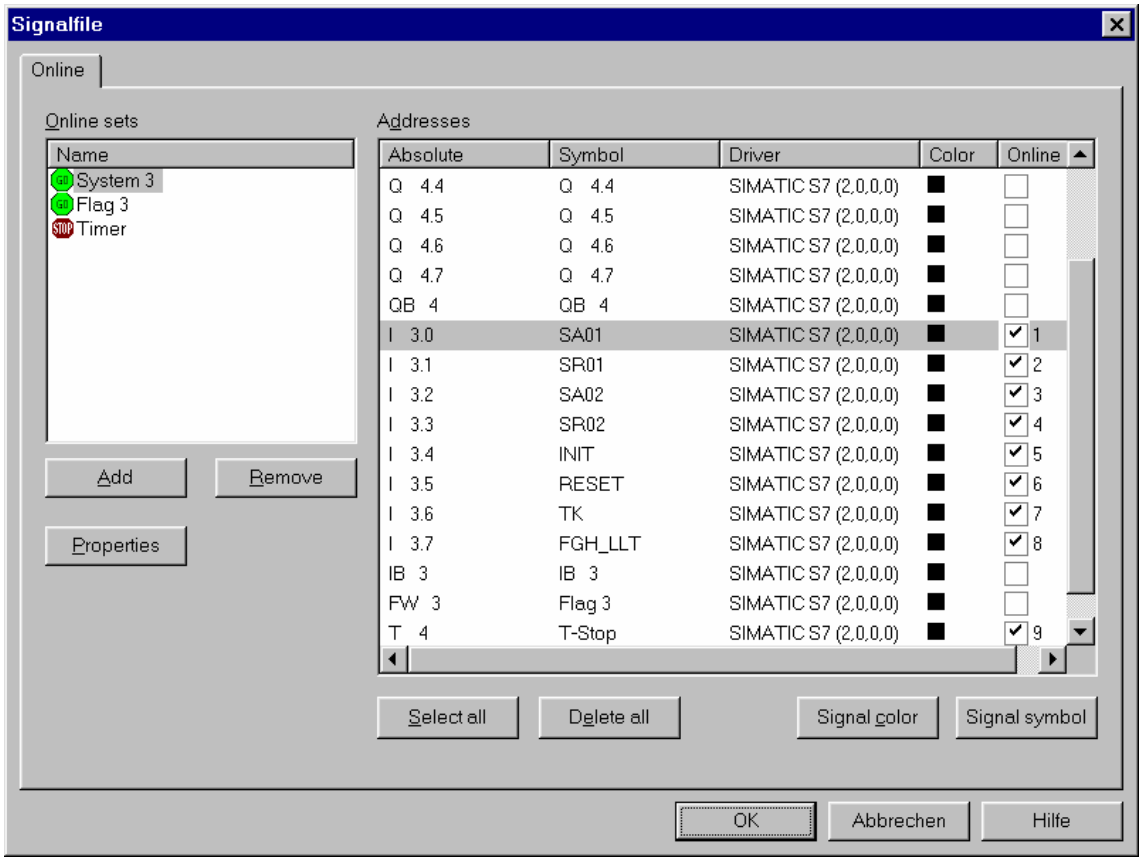


Fig. 5-3 Selecting signals to display

The signals are selected with mouse or keyboard. When using the keyboard the signal is selected with <ENTER>. Use the mouse to select the signal by checking the check box in the online window. A selected signal is given a number indicating its sequence position during display. You can change an existing sequence number by double-clicking on the corresponding number in the online column and entering a new position. A selected signal is given a number indicating the display sequence. In this way you can make sure that logically related signals are displayed next to each other. Signals already selected can be deselected simply by reselection.

Use the *Signal symbol* button to change the symbol name and the comments on a selected signal.

Use the *Signal color* button to change the color of the signal in the online window.

The *Select all* button automatically selects all signals. The entire selection is deleted with *Delete all*.

Signal windows can be added, deleted, and attributes modified with the buttons *Add*, *Remove*, and *Properties* (see *section 4.2 Online signal selection*).

After selecting the desired signals click on OK. The signal curve is displayed in the signal window.

5.3 Scaling of register values

With the help of online scaling you can influence the display of analog values in respect to their number value and the graphical representation. For example, you can convert signal values to physical units (m, kg ...) and display them correspondingly on the screen. You can enter unit, factor, and offset of an analog value. The analog signal is converted according to the following formula:

Display value = Factor • Measured value + Offset

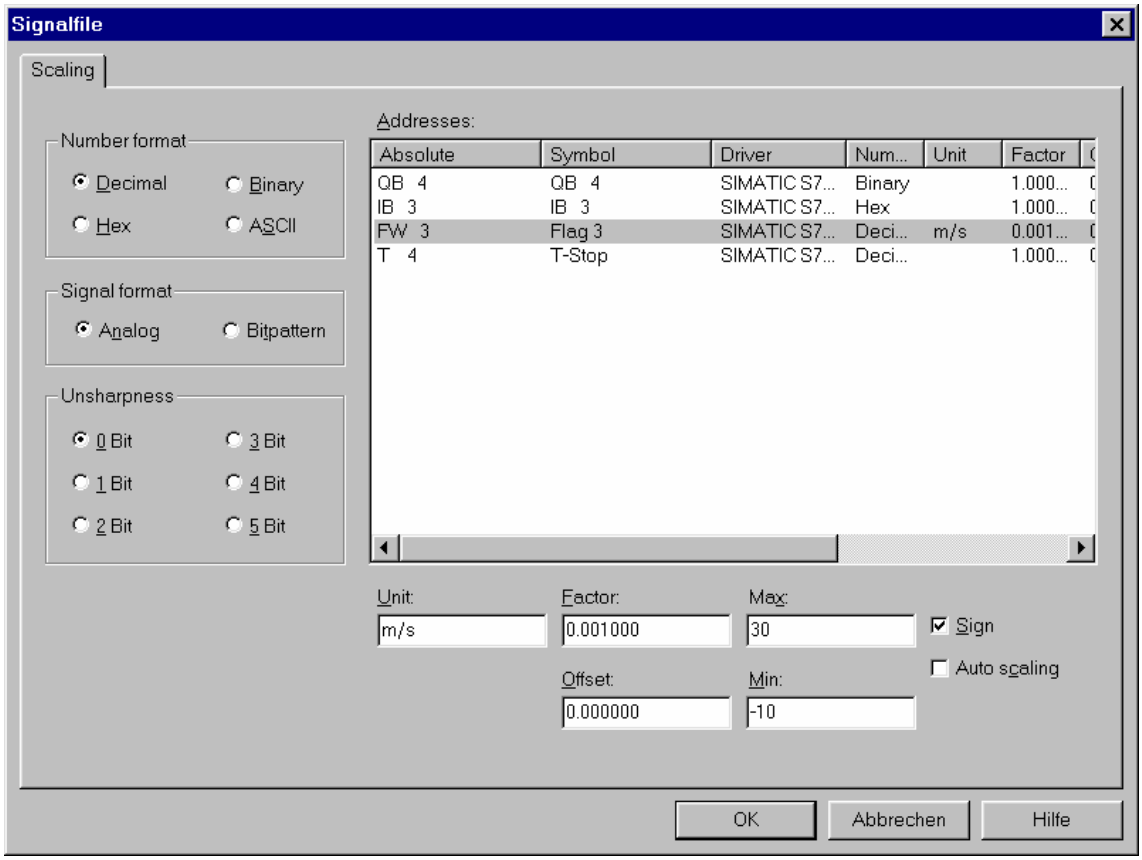


Fig. 5-4 Scaling of register values

Select the signal to be scaled and change if necessary the default values in the corresponding text boxes. Under *Sign* is indicated whether the measured value should be interpreted as signed (two's complement) or unsigned.

Under *Number format* you change the format of the selected measured value. The measured value can be displayed not only with *Decimal* and *Binary*, but also as a pure hexadecimal value ($00000000...$FFFFFFFF) and as an ASCII character.

If you are interested in seeing the bit pattern for a particular measured value, then under *Signal format* switch to *Bit pattern*. PLC-ANALYZER pro then displays the signal as bit pattern.

In order to reduce the amount of recorded data for lightly fluctuating analog values, you can set the *Unsharpness* from 1 to 5 bits. Variation of measured values in these bits is then simply ignored.

PLC-ANALYZER pro can automatically adapt the vertical scale of an analog signal, so-called *Auto scaling*. The signal is scaled in such a way that the maximum value lies at the upper end of the scale and the minimum value at the lower end. Automatic scaling is preset as default.

If you desire fixed scaling of the displayed values, then you can switch off the *Automatic scaling* check box. Now you can manually enter the scaling limits for the display under *Min* and *Max*. Entry takes place according to the format set under *Number format*.

Fixed scaling is useful, for example, if you would like to "zoom" small changes of a measured value in a particular value range. Please note that changing the sign interpretation may cause the minimum and maximum values to be reversed.

5.4 Signal cursor

The vertical green line (blinking) is the signal cursor. All values displayed in the display fields, such as current level and time, are always in respect to the current cursor position. You simply move the cursor to the signal position you wish to investigate and then read the corresponding measurement values.

The signal cursor can be easily moved either with the mouse or the keyboard. You can move the cursor to a desired position e.g. by moving the mouse. If you move the cursor through the left or right border of the signal display window, the signal file view will scroll slowly forward or backward. The same effect can be achieved by clicking in the address display or on the current values.

Key	Function
⇨	cursor steps forward
⇦	cursor steps backward
SHIFT+⇨	cursor steps forward by 10 pixels
SHIFT+⇦	cursor steps backward by 10 pixels
STRG+⇨	scroll forward by 10 pixels (cursor does not move)
STRG+⇦	scroll backward by 10 pixels (cursor does not move)
Page⇧	page up
Page⇩	page down
Home	cursor to beginning of screen on left
End	cursor to end of screen on right
STRG+Home	cursor to beginning of signal file
STRG+End	cursor to end of signal file

Table 5-1 Signal cursor

5.5 Time information

The bottom portion of the graphics signal window contains important information and options in respect to time display and time difference measurement.

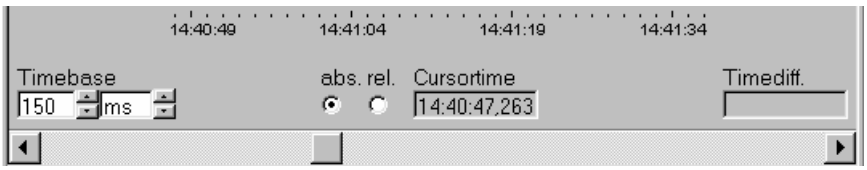


Fig. 5-5 Time information

5.5.1 Absolute and relative time display

In the *Cursor time* text field the current time at the signal cursor position is displayed continuously. You can select between two different display possibilities:

1. Relative: Time display relative to the beginning of the signal file.
2. Absolute: System time (computer time) from the moment of incoming data.

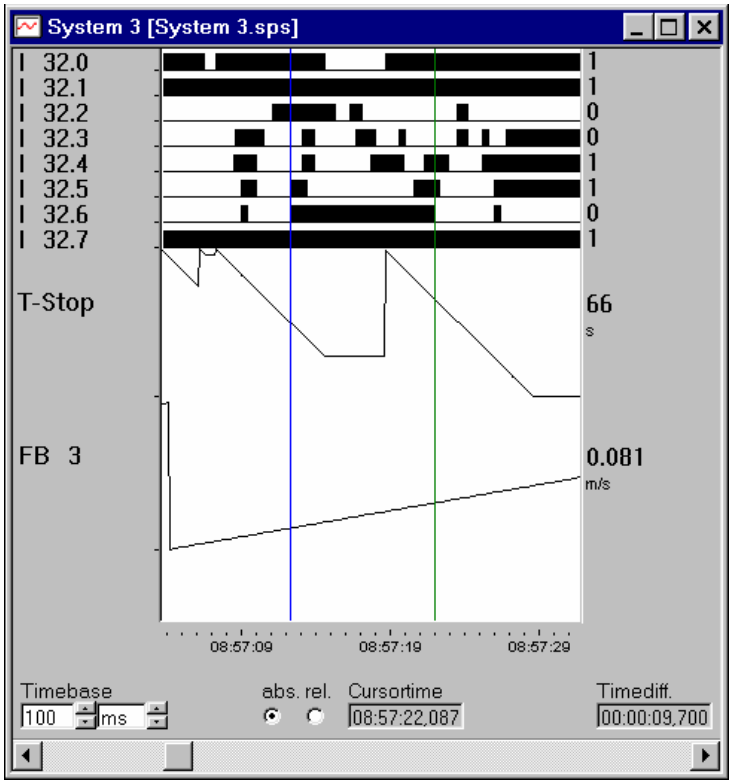
Selection takes place using the *rel-* and *abs*. radio buttons. The general format for time display is: hh:mm:ss,xxx (hh = hour, mm = minute, ss = second, xxx = millisecond).

5.5.2 Setting the time base

The time base gives the time per screen pixel. The setting takes place under *Time base*. Activate the left spin field with the mouse in order to modify the time base. Alternatively, you can enter the new time base directly into the text field. Confirm your entry with <ENTER>.

The time-base unit is automatically adapted to the number value entered. When the number value moves outside certain limits the unit is automatically changed to the next lower or higher unit. If the signal file is long enough, you can also manually change the unit by using the right spin field.

5.5.3 Time difference measurement



PLC-ANALYZER pro uses the time difference measurement function for measuring signal time difference.

First, position the signal cursor on a reference point. Now activate the time difference measurement by clicking the right mouse button (keyboard: Ctrl + ⇩) in the display area of the signal window. Select the menu item *Difference cursor* in the context menu. The reference point is marked by a fixed reference cursor. The blue, non-blinking reference cursor is hidden at first by the signal cursor and becomes visible after the cursor is moved. Moving the signal cursor causes the time difference between the reference cursor and the signal cursor to be calculated and displayed in the text field *Time difference.*

The time difference measurement can be combined with the search functions described below, so that an exact positioning e.g. at interesting signal edges is possible.

5.6 Search functions

PLC-ANALYZER pro supports searching according to specific bit patterns, signal edges, triggers, or specific points in time within the signal file.

Activate the search function with the menu Find or by clicking the right mouse button in the display area of the signal window (keyboard: Ctrl + ⇩).

5.6.1 Find trigger

The triggers set within a signal file are displayed as vertical dashed lines. Select the menu item *Find – Find trigger*, in order to activate the *Find trigger* window.

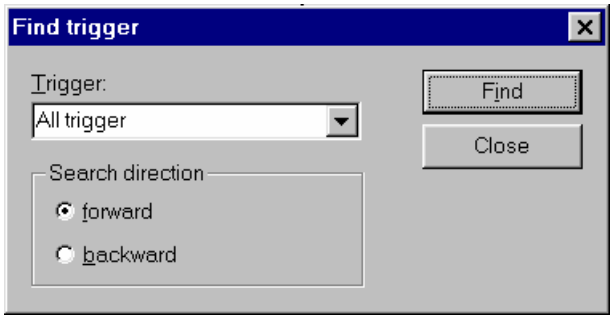


Fig. 5-7 Find trigger

Enter the name of the trigger to find in the *Trigger* text field. The option "All triggers" specifies search for all triggers. Specify the search direction with *forward* and *backward*. Click on *Find* to start the trigger search. The program now searches for the next trigger in the given search direction and positions the signal cursor on it.

5.6.2 Find time

Select the menu item *Find* - *Find time* to find a specific point in time in a signal file.

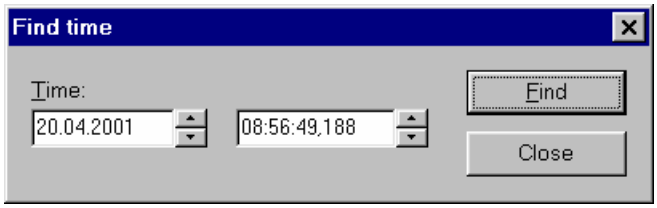
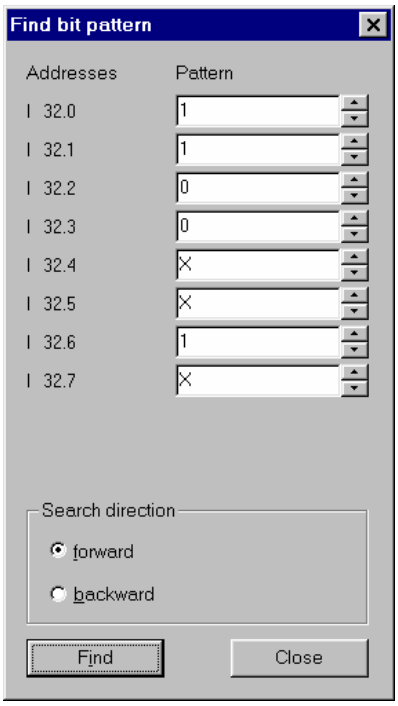


Fig. 5-8 Find time

Enter the desired time. Alternatively, you can change the search value by clicking with the mouse on the appropriate spin field. The time search occurs corresponding to the setting in the signal window (absolute or relative time).

The time search is started with *Find*. The program searches for the corresponding time stamp and positions the signal cursor on it.

5.6.3 Find bit pattern



In order to search for a particular binary signal pattern, select the menu item *Find – Find bit pattern*.

All bit addresses displayed in the active signal window are listed under *Addresses*. Now enter the desired search pattern in the text fields to the right of the addresses. Permitted signal conditions are "1", "0", and "X" (1 = high, 0 = low, X = don't care). Alternatively, you can change the search values by clicking with the mouse on the appropriate spin field.

Specify the search direction with *forward* and *backward*. Click on *Find* to start the trigger search.

The program now searches for the next bit pattern in the given search direction and positions the signal cursor on it.

Fig. 5-9 Find bit pattern

5.6.4 Search for analog value

To find a specific analog value in a signal file you use the analog-value search. Select the menu item *Search - analog value*.

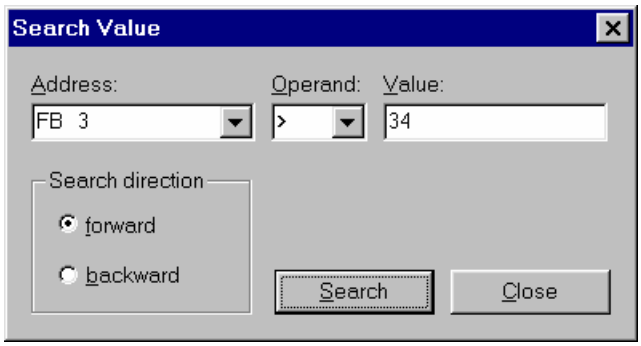


Fig. 5-1 Search for analog value

First, select under *Address* the signal to be examined. Then enter the *Operand* and the *Value* you wish to find.

Specify the search direction with *forward* or *backward*. Start the search with *Search*.

The program finds the next analog value in the given search direction corresponding to the given parameters. The signal cursor is set to the found value.

5.6.5 Find edge

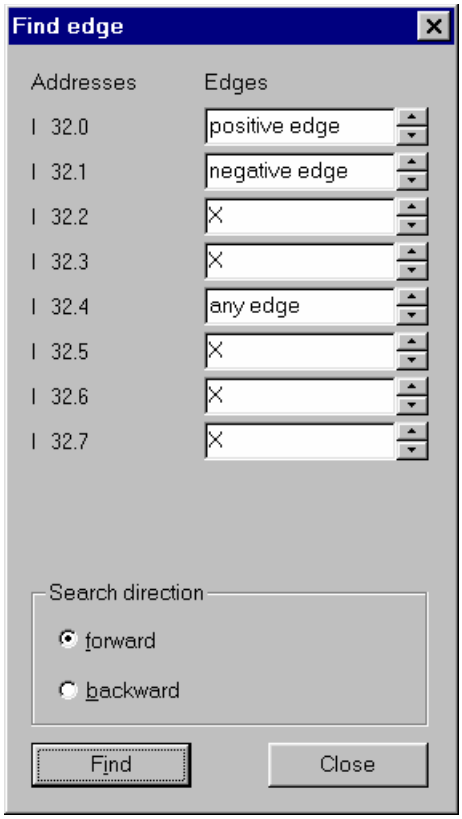


Fig. 5-10 Find edge

In order to search for a particular signal edge, select the menu item *Find – Find edge*.

All bit addresses displayed in the active signal window are listed under *Addresses*. Now enter the desired edge form in the text fields to the right of the addresses. Permitted entries are "+", "–", "B", and "X" (+ = positive edge, – = negative edge, B = any edge, X = don't care). Alternatively, you can change the search values by clicking with the mouse on the appropriate spin field.

Specify the search direction with *forward* and *backward*. Click on *Find* to start the search.

The program now searches for the next edge pattern in the given search direction and positions the signal cursor on it.

5.7 Comparing signal files

PLC-ANALYZER pro features the capability of comparing two signal files with each other. Open the signal files to be compared. Then select the menu item *Compare* in the signal-file menu. The signals of both signal files are overlapped in the online window, thus making a comparison of the signals possible.

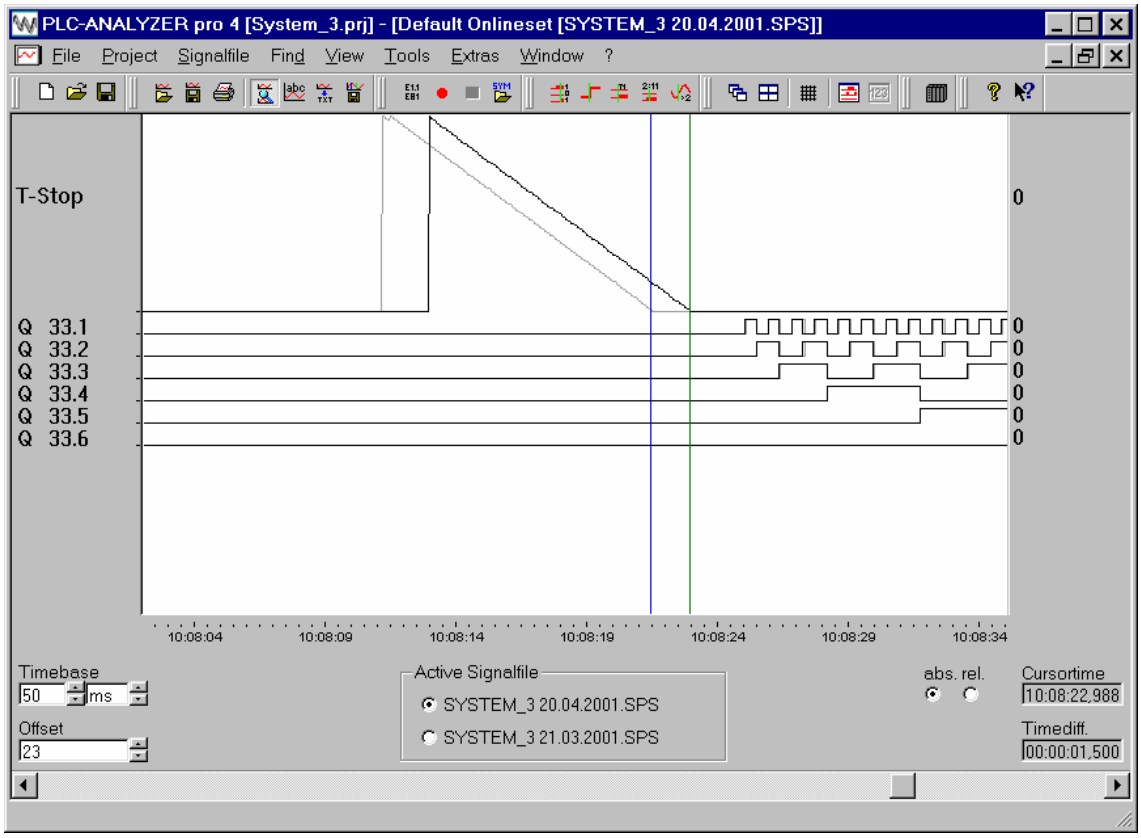


Fig. 5-2 Comparing signal files

The signals of the non-active signal file are displayed in gray. The signals of the active signal file appear in the color previously set. Under *Active signal file* you specify the active signal file.

All signal-file functions (e.g. cursor time, time difference, search functions, etc.) refer to the active signal file.

With *Offset* you can shift the signals of the active signal file horizontally. This enables you to specify a common reference point for the signals.

5.8 Signal statistics

With PLC-ANALYZER pro you can create a statistical overview of the signals over time. Select the menu item *Statistics* in the signal-file menu in order to obtain various statistics on a given signal.

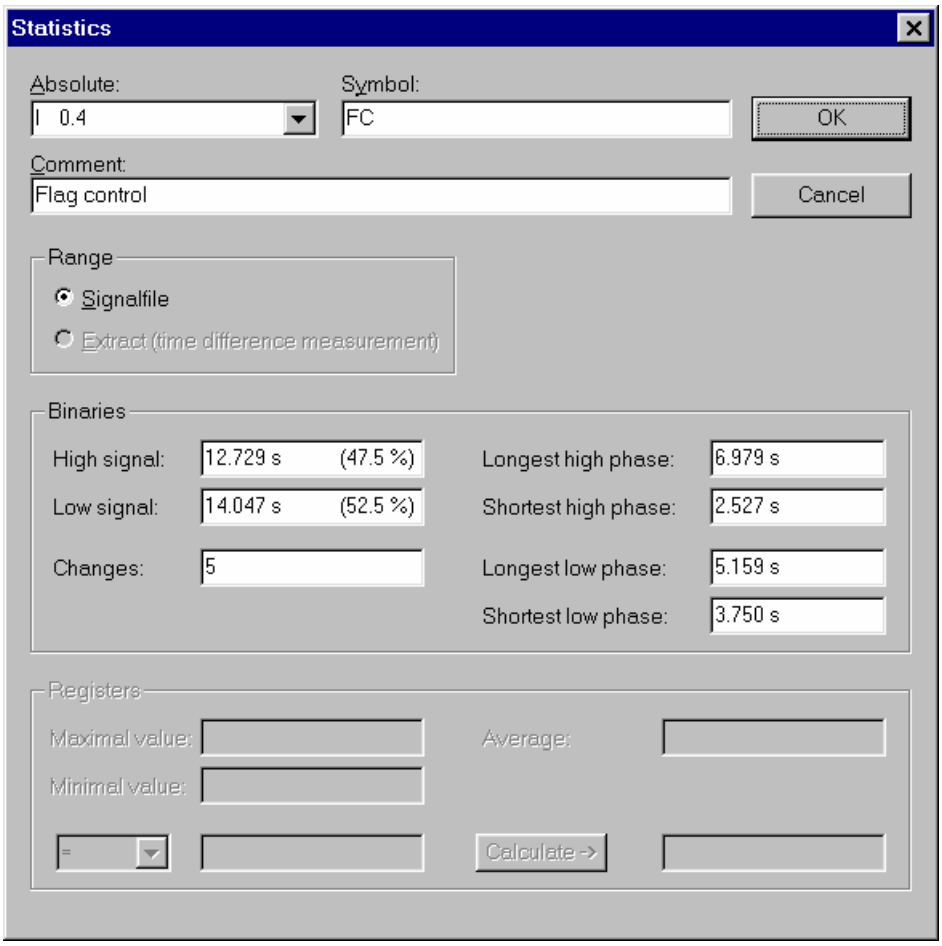


Fig. 5-3 Signal statistics

Under *Absolute* select the address for which statistical information is to be obtained. Symbol name and comments of the selected address are adapted automatically.

Under *Range* select the desired range of the signal file for which the evaluation takes place. The radio-button option *Extract (time-difference measurement)* can only be activated if you have previously selected a range for the time-difference measurement in the signal window.

The following table explains the statistical evaluation for a discrete signal (bit address):

Field	Explanation
Signal high	Gives the time during which the signal in the selected range was HIGH (logical 1)
Signal low	Gives the time during which the signal in the selected range was LOW (logical 0)

Field	Explanation
State change	Number of signal-edge changes in the selected range
Longest high phase	Gives the longest time during which the signal in the selected range was HIGH (logical 1)
Shortest high phase	Gives the shortest time during which the signal in the selected range was HIGH (logical 1)
Longest low phase	Gives the longest time during which the signal in the selected range was LOW (logical 0)
Shortest low phase	Gives the shortest time during which the signal in the selected range was LOW (logical 0)

Table 5-2 Statistical evaluation of a bit address

For register values (byte, word, or double word) the following information is displayed:

Field	Explanation
Maximum value	Maximum value of the signal in the selected range.
Minimum value	Minimum value of the signal in the selected range.
Average	Average value of the signal in the selected range.

Table 5-3 Statistical evaluation of a register address

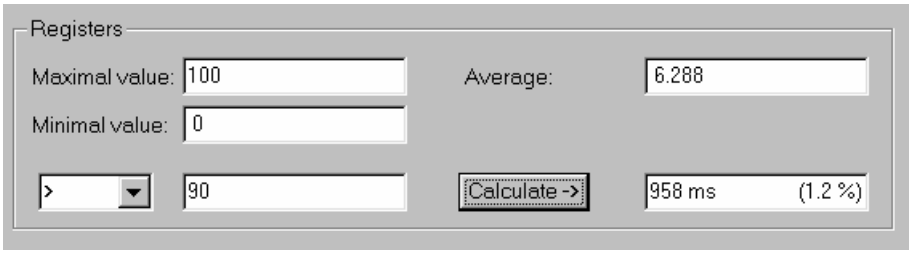


Fig. 5-4 Signal statistics - register values

When selecting a register value you can also determine how often a particular signal value has occurred. Enter an operand and a signal value. Click on the *Calculate* button and the result is displayed.

5.9 Adapting signal display

PLC-ANALYZER pro makes possible the individual configuration of signal display. You can change the signal color, shift signals, and title signals.

5.9.1 Shifting signals

Position the mouse cursor in the left column of the online window onto the name of the PLC address that you wish to shift. Now simply drag the signal (left mouse button down) to the desired position.

5.9.2 Changing signal color

Position the mouse cursor in the left column of the online window onto the name of the PLC address whose color you wish to change. Press the right mouse button and select the menu item *Change signal color*. Then choose the desired signal color.

5.9.3 Labeling the signals

Select the *New signal text* menu item in the signal-file menu and click at the position where the text should appear. Now enter the text into the text field displayed. The text is accepted when you press RETURN.

Already existing text can be moved at will. Simply click the corresponding text and drag it (left mouse button down) to its new position.

A signal text can be modified by double-clicking on it. The edited text is accepted with RETURN.

To delete an existing text right-click on it and select the menu item *Delete*.

5.9.4 Modifying symbol addresses and comments

Position the mouse cursor onto the PLC address whose symbol or comments you wish to modify. Right-click the mouse and select the menu item *Signal info*.

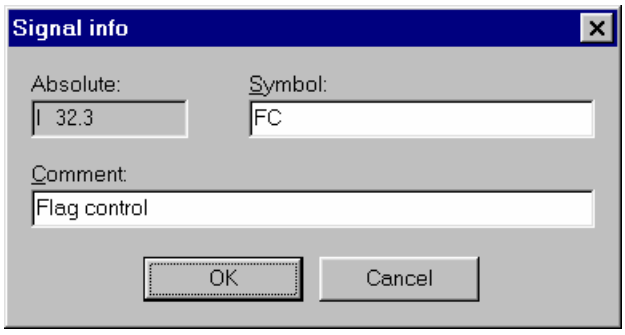


Fig. 5-5 Signal info

In the *Signal info* window you can modify both symbol address and symbol comments of the selected signal.

5.10 Saving a signal file

To save changes in a signal file select in menu *File* the menu item *Save signal file* or *Save signal file as*.

5.10.1 Saving an extract

PLC-ANALYZER pro enables you to also save extracts of a signal file. Simply select the desired area with the help of the time difference measurement. Place the signal cursor on the starting point of the extract to be saved. Now activate the time difference measurement (see *section 5.5.3 Time difference measurement*). Finally, place the signal cursor at the end position of the extract.

Now select in menu *Signal file* the option *Save extract*. Enter a name for the extract and click on *Save* to save the area between the reference cursor and the signal cursor.

5.11 Printing a signal file

PLC-ANALYZER pro lets you print signal files. You can print either entire signal files or extracts of signal files. You reach the printer selection window through the *Print...* menu item in the *File* menu.

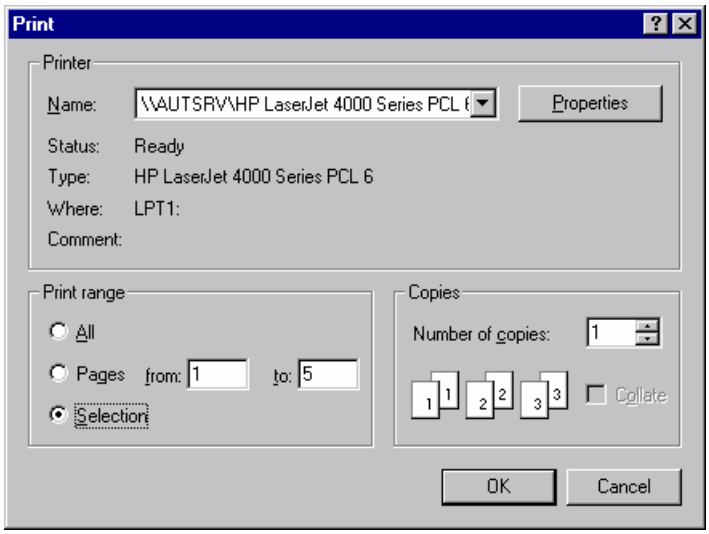


Fig. 5-11 Printer selection window

Under *Printer* select the desired printer. Enter the desired portion of the signal file to be printed. Click on the option radio button *Current page* if you would like to print the displayed area in the active signal window. Select *All x pages* to print the entire signal file with the time base set in the current online window.

The option field *Copies* indicates how many copies of the signal file should be printed.

Start printing with *OK*. An information window appears during printing. Following you see an example printout.

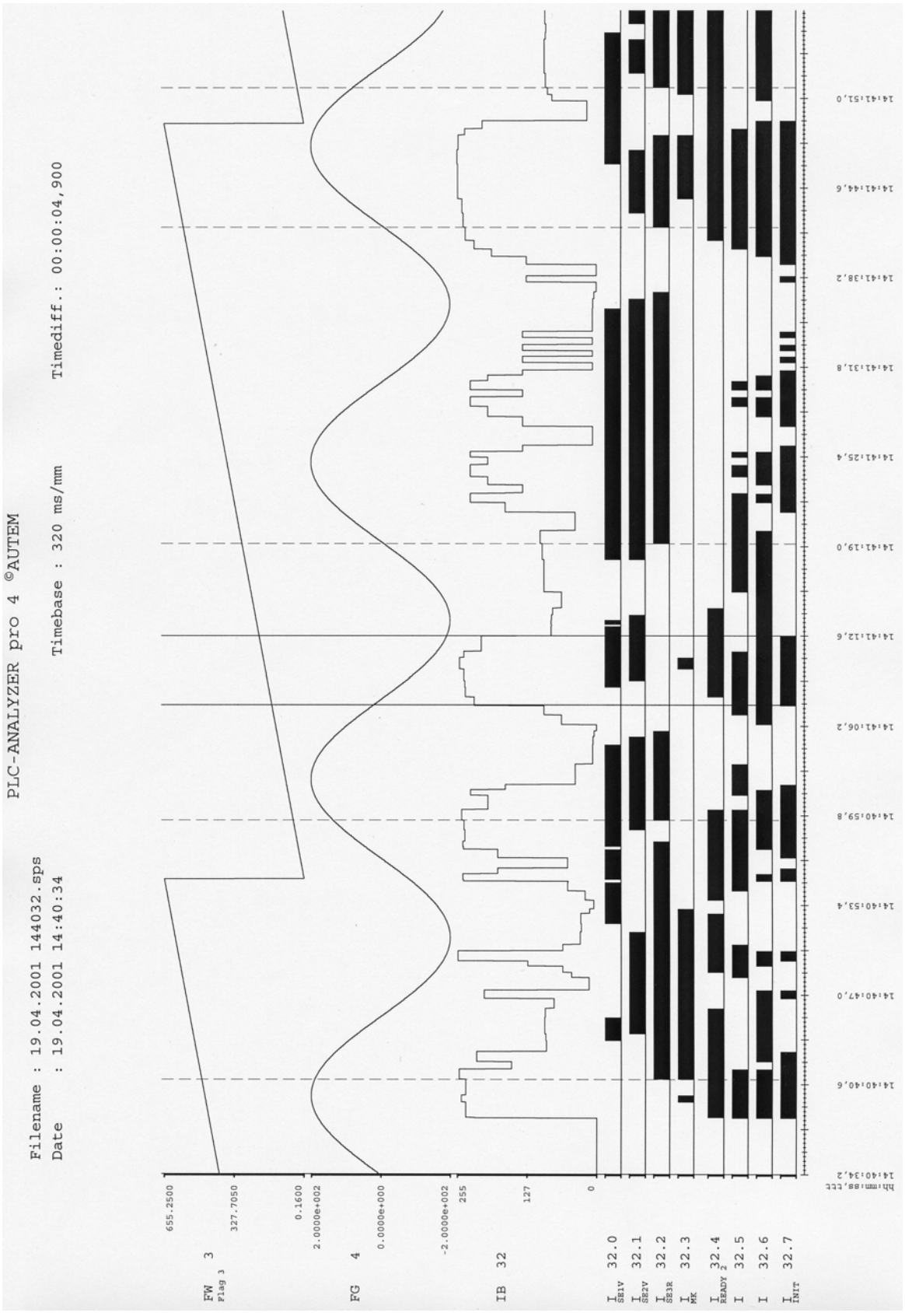


Fig. 5-12 Printout of a signal file (not to scale)

5.12 ASCII-Exporting signal files

PLC-ANALYZER pro can export signal files either in ASCII format or as graphic (.bmp) files. This is appropriate if you wish to reuse the measured values, e.g. in a spreadsheet program.

You call up the export selection window by selecting the *Export...* menu item in the *File* menu.

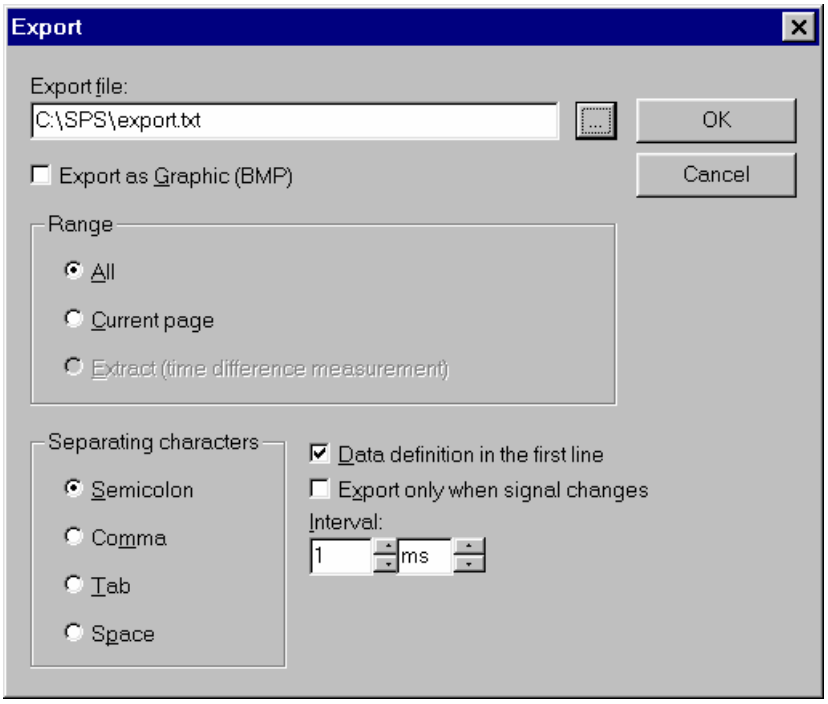


Fig. 5-13 Export in ASCII format

5.12.1 Export as graphic (bitmap)

Enter the name of the export file under *Export file* and check the check box *Export as graphic (BMP)*. Click the *OK* button to export the signal file as a graphic in bitmap format.

5.12.2 Export as ASCII text

Under *Range* you select the desired portion of the signal file to be exported. You can only check the radio button *Extract* (*time difference measurement*) if you have previously selected a range by time difference measurement.

The name of the export file is given in *Export file*. You specify under *Separators* which characters are used to separate the individual measured values. Checking *Data definition in the first line* causes the data columns to have a header.

Use *Interval* to set the duration between exported signals. Select *Export only when signal changes* when you want to see signal changes only. This reduces the size of the export file.

The following values are exported: relative time, absolute time, signal values, triggers, and any errors that may have occurred during data acquisition. The export file is automatically formatted so that it can be directly used for further processing in MS-EXCEL, for example.

Relative time	Absolute time	Q 3.1	Q 3.2	Q 3.5	Q 3.7	FW3	T 1	Z 1	10 DW 1	Trigger	Errors
0	12:50:40.000	0	1	0	0	8677	95	55	29745	0	0
50	12:50:40.050	1	1	0	0	8677	95	56	32301	0	0
100	12:50:40.100	1	1	0	0	8816	87	57	32301	0	0
150	12:50:40.150	0	0	0	0	8957	80	58	30679	0	0
200	12:50:40.200	1	0	0	0	8957	72	59	28123	0	0
250	12:50:40.250	1	0	0	0	9097	72	60	28123	1	0
300	12:50:40.300	0	1	0	0	9238	65	61	25567	0	0
350	12:50:40.350	1	1	0	0	9238	58	62	23011	0	0
400	12:50:40.400	1	1	0	0	9377	58	63	23011	0	0
450	12:50:40.450	0	0	0	0	9517	50	64	20473	0	0
...	...	...	...	...	...	...	...	...	...	...	...

Fig. 5-14 Example of an exported signal file (extract)

NOTE

The time difference between the individual exported signal values corresponds to the time base set in PLC-ANALYZER pro.

5.12.3 Graphical evaluation of signal data in MS-EXCEL

In the following you see examples for the graphical evaluation of signal data in a spread-sheet program (Microsoft EXCEL®). The examples shown are designed to give you ideas. Interesting results can also be obtained by using other analysis programs, e.g. mathematics and statistics programs.

Start EXCEL and open the ASCII file exported by PLC-ANALYZER pro. After you have responded to some queries regarding import (e.g. used separators), EXCEL reads the data formatted into cells (see *Fig. 5-14*).

Now you can use the built-in graphics functions of EXCEL to obtain meaningful graphical representations for various application purposes.

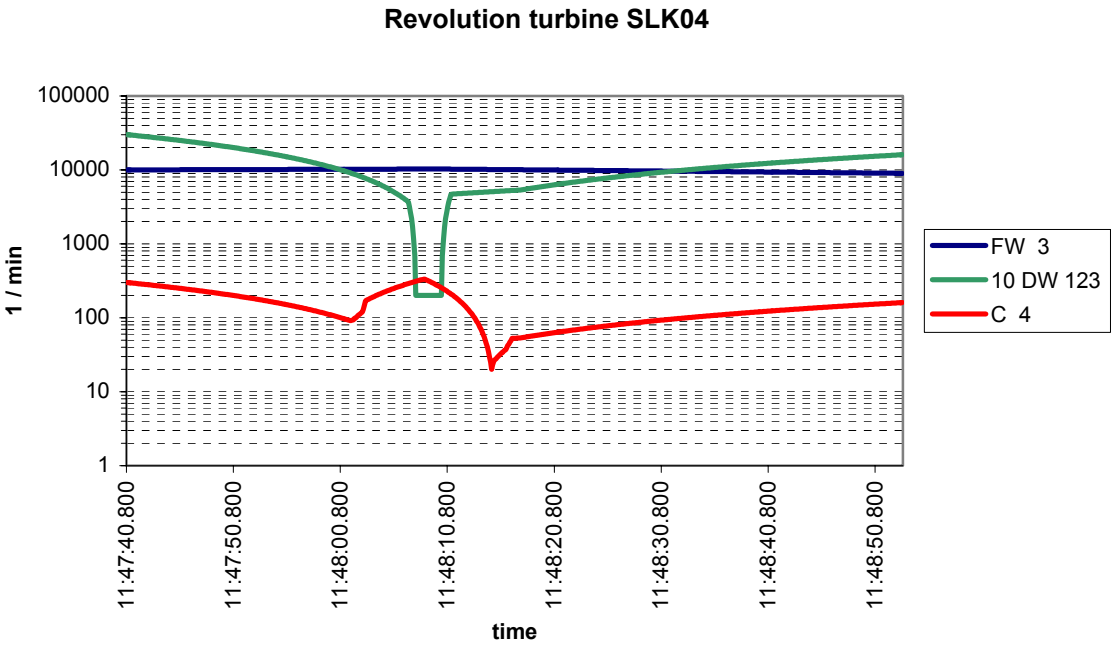


Fig. 5-15 Logarithmic representation of PLC analog signals with EXCEL

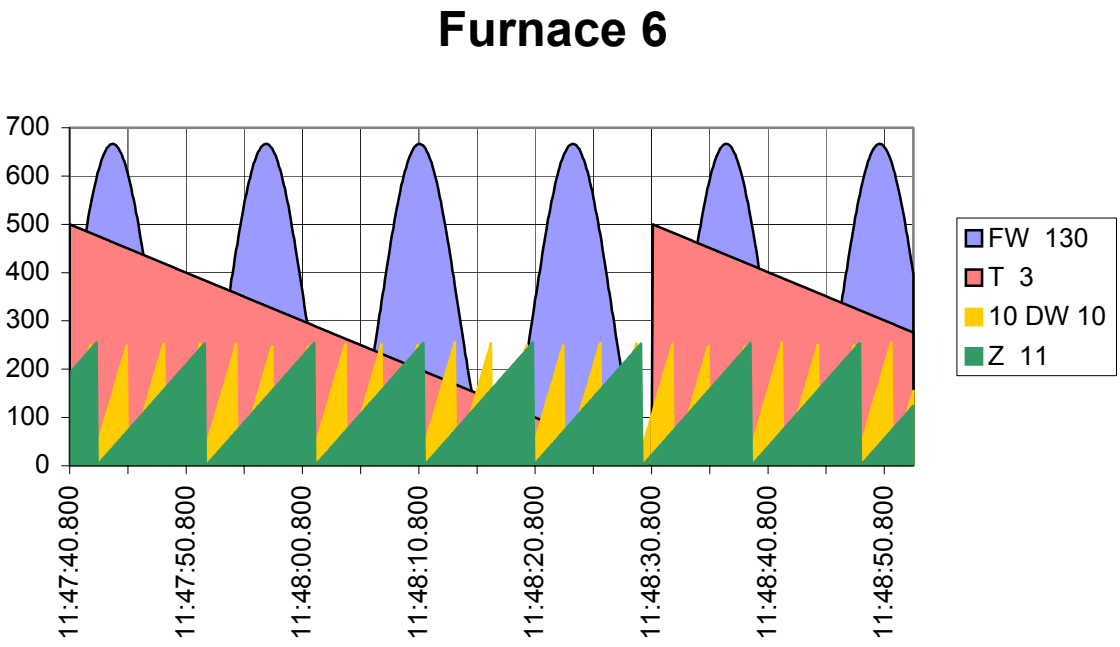


Fig. 5-16 3D representation of PLC analog values with EXCEL

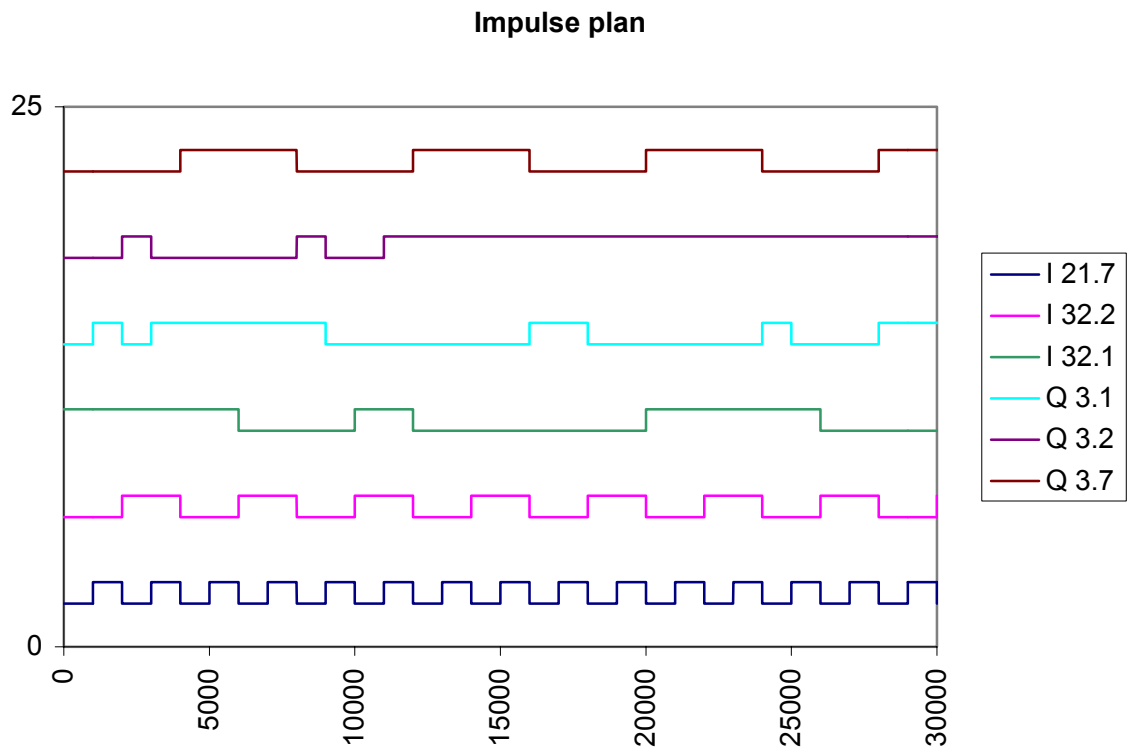


Fig. 5-17 Discrete signals with EXCEL

6 Remote diagnosis

With suitable software you can use the PLC-ANALYZER pro for remote troubleshooting. For this work you can use as well the local LAN the internet or the telephone line.

6.1 Remote diagnosis with terraLink®

In connection with the terraLink® modem system (AUTEM) you can acquire data from each PLC worldwide. Connect the PLC to analyze to a terraLink modem. When recording begins a connection is automatically made to the remote modem of the PLC, if remote maintenance is activated (*see section 3.4 Remote maintenance*). After the connection was established successfully, data will be forwarded from the PLC to the PC over the telephone line. A PC at the remote station is not necessary. Of cause you can use the connection to program the remote PLC (e.g. with STEP 7).

6.2 Remote diagnosis with remote PC

Another elegant way is the use of a remote access software like NetMeeting, Reachout or pcAnywhere. Therefor install the PLC-ANALYZER pro on the Remote-PC. With the remote access software you can remote control the remote PC over LAN, internet or telephone line.

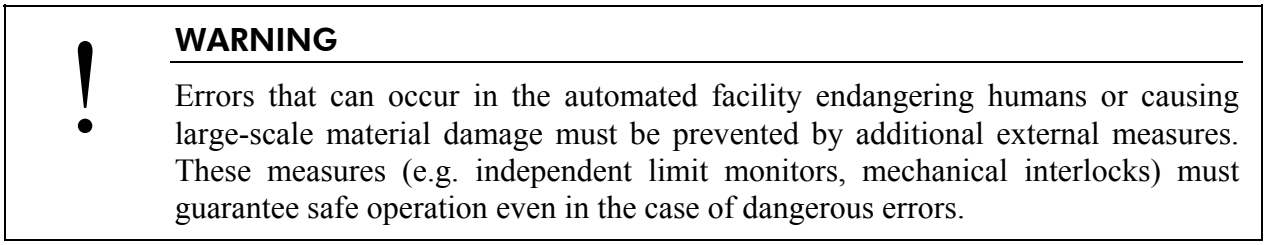
7 Driver appendix Siemens SIMATIC S5

This driver appendix describes the particularities of the following PLC drivers and gives you hints on using them.

- Siemens SIMATIC S5 - PG-Interface - cycle-precise

Both drivers listed make possible the acquisition of PLC signals through the programming interface of the PLC. The second driver also makes possible cycle-precise data acquisition. Section *7.4 Cycle-precise acquisition* describes the particularities of this recording mode.

It is important that you read the driver appendix before using a PLC driver. Please pay attention to the WARNINGS that advise you on possible dangers when using PLC-ANALYZER pro.



WARNING

Errors that can occur in the automated facility endangering humans or causing large-scale material damage must be prevented by additional external measures. These measures (e.g. independent limit monitors, mechanical interlocks) must guarantee safe operation even in the case of dangerous errors.

7.1 Installation

The PLC driver can be installed while PLC-ANALYZER pro is operating. Select *PLC driver* in the menu *Options*. In the window PLC driver click the button *Add*. If the desired driver is not in the list, then you can install a new driver by clicking on the *Diskette* button. Insert the driver diskette into the diskette drive and click on *OK*.

With PLC-ANALYZER pro you can load the same or different PLC drivers more than once. For example, you can acquire signal data from two SIMATIC S5 simultaneously, that are connected to two different COM ports of the PC.

7.1.1 Installing additional hardware

If you have already connected your programming unit (or your PC) for programming under STEP 5 (or alternative programming software) with the automation device over a serial cable, then you normally must do nothing else.

Otherwise connect a free COM port (serial connection) of your programming unit (or PC) with the PG interface of the automation device. Because the serial PG interface on the automation device functions as a current interface (TTY/20mA) , you will need for connecting your PC an appropriate connecting cable with integrated RS232 TTY converter (AUTEM Order# ANA1500 or Siemens Order# 6ES5 734-1BD20).

7.1.2 Installing additional software

No software is required in addition to the PLC-ANALYZER pro basic module and the PLC driver.

7.2 Configuring the PLC driver

After installing the driver you can change important parameters under *Properties*. If you have loaded several drivers, you can set the properties for each driver individually.

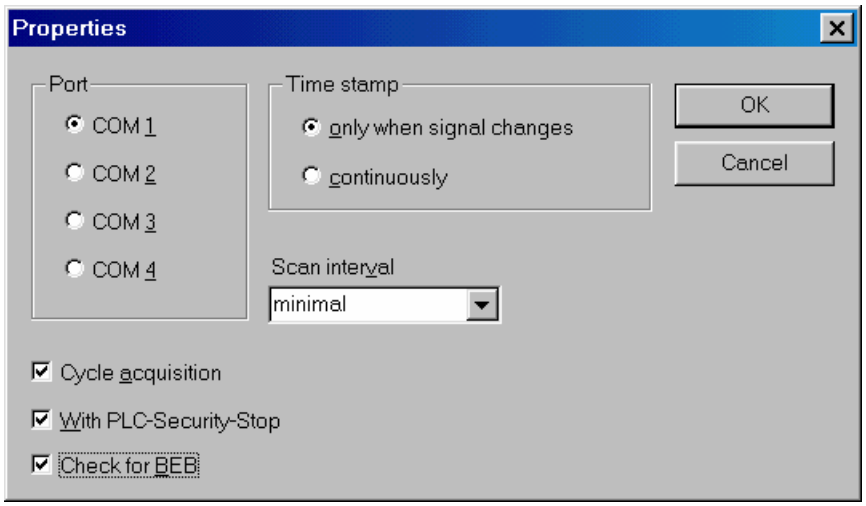


Fig. 7-1 Driver settings (Siemens SIMATIC S5)

Check under *Port* the COM port (serial interface) of your computer to which the connecting cable to the automation device is connected.

For the cycle-precise driver variant (see *section 7.4 Cycle-precise acquisition*) you can activate the *Cycle-precise acquisition*. This setting has priority over the choice of acquisition mode (s. *section 4.5* Modes of data acquisition). You also specify here whether for safety reasons the automation device should be stopped before and after transfer of the acquisition modules. You also specify whether a conditional module end should be checked.

Use *Time stamp* to specify whether the time stamps should be entered into the signal file continually (at every scan point) or only for signal changes. For a continuous time stamp the exact scan points are documented even for a signal which does not change. The signal files are therefore larger.

Under *Scan interval* enter the length of time between read-out of data from the PLC. A longer scan interval may be chosen for non-critical time signals, e.g. temperature. The signal files thus created then become smaller.

7.3 Data acquisition

7.3.1 Supported PLC models and CPUs

The following models of the SIMATIC S5 family are supported by the AS511 driver:

AG	CPU	Particularities
90U		No acquisition of PW, No cycle-precise acquisition
95U		No acquisition of PW
100U	100, 102, 103	
101U		No cycle-precise acquisition
115U	941, 942, 943, 944, 945	
135U	921, 922, 928, 928B	
150U		No cycle-precise acquisition
155U	946, 947, 948	

Table 7-1 Overview of the supported SIMATIC S5 models

Other automation devices and CPUs from the S5 family are generally compatible with PLC-ANALYZER pro, but have not been explicitly tested.

7.3.2 Recordable PLC addresses

The following table shows the recordable addresses and the corresponding address syntax.

Syntax	Address type	Example
Qx.z	Output byte x, bit z	Q32.4
QBx	Output byte x	QB9
QWx	Output word x	QW14
QDx	Output double word x	QD98
Ix.z	Input byte x, bit z	I17.0
IBx	Input byte x	IB127
IWx	Input word x	IW12
IDx	Input double word x	ID124
Fx.z	Flag byte x, bit z	F3.7
FBx	Flag byte x	FB250
FWx	Flag word x	FW24
FDx	Flag double word x	FD134
FGx	Flag x (floating-point representation)	FG104

Syntax	Address type	Example
FWAx	Flag word analog[4] x	FWA26
PWx	I/O word x (only input)	PW214
Sx.z	Special flag x, bit z	S1010.1
SYx	Special flag x	SY2027
SWx	Special flag word x	SW1423
SDx	Special flag double word x	SD1028
SGx	Special flag x (floating-point)	SG1424
Tx	Timer x	T2
Cx	Counter x	C5
yDLx	Left data byte x from DB y	20DL15
yDRx	Right data byte x from DB y	21DR53
yDWx	Data word x from data block y	12DW5
yDDx	Data double word x from DB y	27DD0
yDGx	Data x from DB y (floating-point)	2DG54
yDXx	Data word x from DX-module y	22DX15

Table 7-2 Address syntax SIMATIC S5

NOTE

The automation devices of the SIMATIC S5 family allow only byte-oriented data acquisition. PLC-ANALYZER pro automatically converts a given bit address to a byte address. All bits are available for display.

7.3.3 Time behaviour and particularities

NOTE

Acquiring data with PLC-ANALYZER pro results in a small increase in cycle time in the automation device to the same extent that happens with STEP5 in operating mode STAT VAR.

The intervals between scan transfers from the SIMATIC PLC to the computer are dependent on the PLC CPU and the number of acquired signals.

For the SIMATIC S5-115U (CPU942) and the 95U the interval for a byte is approximately 30 ms, i.e. for a cycle time > 30 ms there is one scan for each cycle. For a longer PLC cycle time data transfer is synchronized with the PLC cycle.

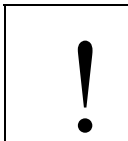
[4] The address type FWA (flag word analog) can be used to acquire analog output values, which are directly transferred in a flag word in the user program to left-justified output format and finally to the analog periphery without using a standard functional module. Backward formatting to the right-justified two's complement form takes place.

For a shorter cycle time the computer does not obtain a scan for each cycle, resulting in a partial loss of information. In normal acquisition mode this loss can be made up by repeated measurement of the signals in question.

If you request more signal addresses than one byte, the minimal transfer interval increases by about 4 ms per byte.

The scan interval for the S5-155U has been fixed in the automation device by Siemens to 150 ms. The CPU 921 (S processor 135U) is the second slowest CPU in regard to the transfer rate; about 70 ms scan interval for the first byte.

7.4 Cycle-precise acquisition



WARNING

For cycle-precise acquisition PLC-ANALYZER pro programs a small extension to the PLC program in the connected automation device. We call attention to the fact that an effect on the operation of the automation device or the PLC program cannot be completely ruled out.

NOTE

In the properties window of the PLC driver (see *section 7.2 Configuring the PLC driver*) you can select whether a conditional module end should be checked with a corresponding notification. Such a command in OB1 can result in the required modules for cycle-precise acquisition not being executed.

During cycle-precise signal acquisition a limited number of signals are acquired in a circular memory within the PLC. The selected signals are stored in the circular memory during each PLC cycle.

Acquisition occurs only through trigger control. After triggering, the acquired signals are transferred to the PC and saved as a signal file. The signal file so created can be displayed and evaluated at a later time. Online display is not possible.

7.4.1 Address entry

For cycle-precise acquisition you can acquire up to 8 addresses (byte or word values) simultaneously. This restriction results from the limited storage capacity of the PLC. The fewer addresses you enter, the more cycles can be acquired in one run.

7.4.2 Trigger condition entry

A trigger condition must be entered for cycle-precise acquisition. In contrast to the other acquisition modes only two AND blocks are available for entering the trigger condition. For each AND block you can refer to a maximum of 8 bit values or 2 analog values in the trigger combination (one analog value corresponds to 4 bit values).

7.4.3 Starting acquisition

Select the option *Cycle-precise acquisition* in the *Properties* windows of the PLC driver.

> **WARNING**
>
> It is absolutely necessary to put the system into a safe state before making any modifications. With the setting "With AD safety stop" PLC-ANALYZER pro switches control of module transfer (or modification) into the STOP state. The operation after the end of recording functions analogously.

Now select in the menu *Project* the menu item *Start acquisition*. The modules are transferred either during operation or after control stop, depending on the setting you have made in the PLC driver window *Properties* (see *section 7.2 Configuring the PLC driver*).

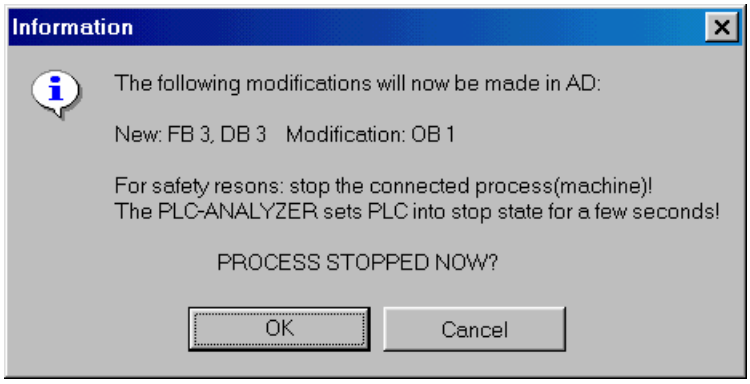

Information
The following modifications will now be made in AD:
New: FB 3, DB 3 Modification: OB 1
For safety resons: stop the connected process(machine)!
The PLC-ANALYZER sets PLC into stop state for a few seconds!
PROCESS STOPPED NOW?
OK
Cancel

Fig. 7-2 Message before modifications in the AD for setting "With AD safety stop"

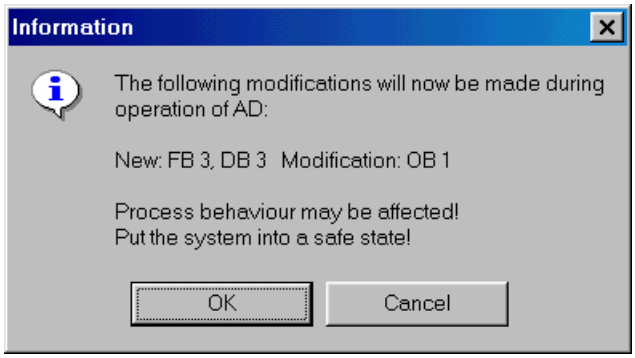

Information
The following modifications will now be made during operation of AD:
New: FB 3, DB 3 Modification: OB 1
Process behaviour may be affected!
Put the system into a safe state!
OK
Cancel

Fig. 7-3 Message before modifications in the AD for setting "No AD safety stop"

Confirm with *OK* only after you have stopped the process or put it in a safe state. Make sure that injury or damage cannot happen by affecting control operation!

PLC-ANALYZER pro searches in the PLC for a free module number and creates a function module and a data module for data recording. In addition, a call to the new function module is appended to the end of OB1.

The controller is now in the RUN state or is switched to the RUN state. Cycle-precise acquisition begins. The screen appears as follows:

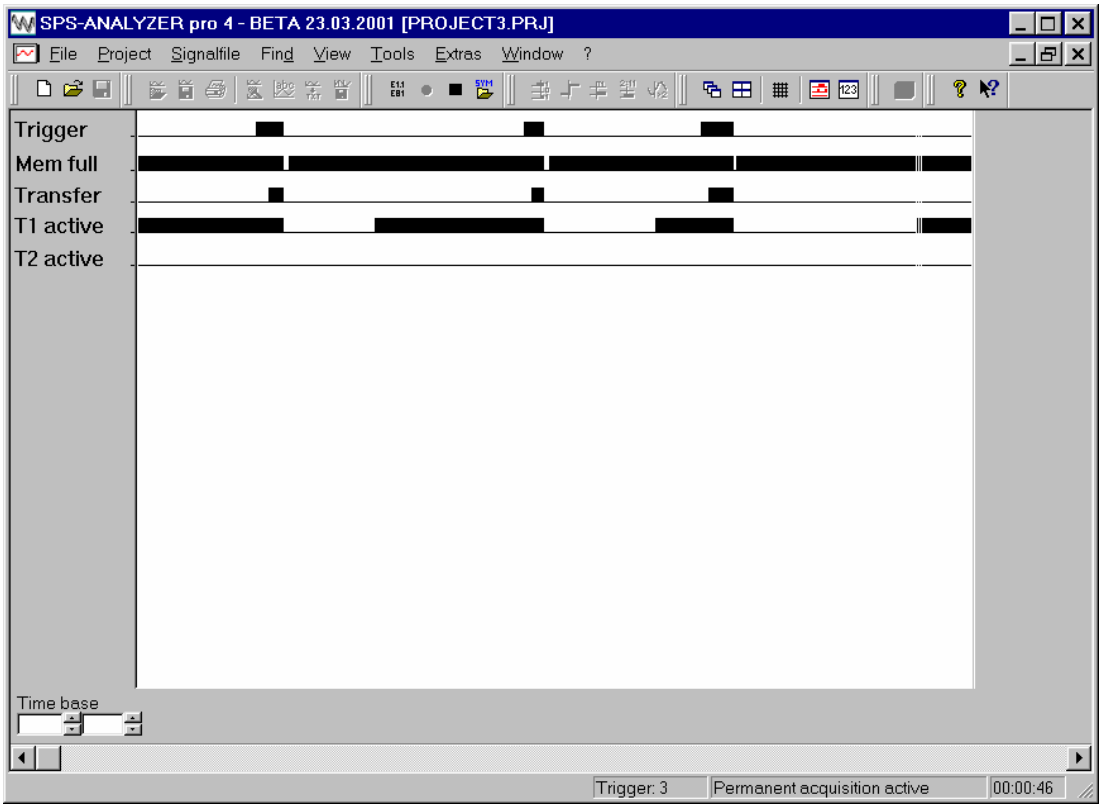


Fig. 7-4 Cycle-precise acquisition status

The displayed signals serve as status display for cycle-precise recording. Their meaning is shown in the following table:

Signal	Meaning
Trigger	Signals whether the trigger condition is fulfilled.
Mem full	Shows that the circular memory is full.
Transfer	The circular memory is transferred from the PLC to the PC and a signal file is created.
T1 active	The trigger combination from AND block # 1 is activated.
T2 active	The trigger combination from AND block # 2 is activated.

Table 7-3 Status display cycle-precise recording S5

Recording is stopped with *Stop acquisition*. You should now stop your system (process) or put the system into a safe state. Removal of the modifications is now done analogously in the stop state or online. One of the following message windows appears:

Information
The following modifications will now be made in AD:
Delete: FB 3, DB 3 Modification: OB 1
For safety resons: stop the connected process(machine)!
The PLC-ANALYZER sets PLC into stop state for a few seconds!
PROCESS STOPPED NOW?
OK

Fig. 7-5 Message before modifications in the AD for setting "With AD safety stop"

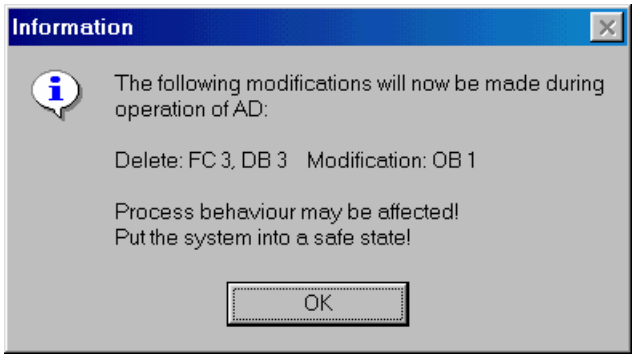

Information
The following modifications will now be made during operation of AD:
Delete: FC 3, DB 3 Modification: OB 1
Process behaviour may be affected!
Put the system into a safe state!
OK

Fig. 7-6 Message before modifications in the AD for setting "No AD safety stop"

Confirm the message after you have stopped your system or put it into a safe state. The original state in the AD is now reinstated.

After the end of acquisition the last signal file created is automatically opened for display. The time base is chosen so that the entire file fits onto the screen.

7.4.4 Particularities of signal display and analysis

Evaluation of cycle-precise acquired signal files is practically identical to normal signal files. One difference is that the data within the PLC cannot be assigned an exact data time. Because of this, the time is always shown relative in cycles. The time base here is "milli-cycles per pixel" (mcp).

8 Driver appendix Siemens SIMATIC S7

This driver appendix describes the particularities of the following PLC drivers and gives you hints on using them.

- Siemens SIMATIC S7 - MPI / PPI / PROFIBUS - cycle-precise
- Siemens SIMATIC S7 - Industrial Ethernet - cycle-precise

The listed driver SIMATIC S7 - MPI / PPI / PROFIBUS allows acquisition of PLC signals through PROFIBUS and all usual MPI/PPI PLC circuits from Siemens. The SIMATIC S7 Industrial Ethernet driver makes it possible to record data via Industrial Ethernet.

It is important that you read the driver appendix before using a PLC driver. Please pay attention to the WARNINGS that advise you on possible dangers when using PLC-ANALYZER pro.

> **!** **WARNING**
>
> Errors that can occur in the automated facility endangering humans or causing large-scale material damage must be prevented by additional external measures. These measures (e.g. independent limit monitors, mechanical interlocks) must guarantee safe operation even in the case of dangerous errors.

8.1 Installation

The PLC driver can be installed while PLC-ANALYZER pro is operating. Select *PLC driver* in the menu *Options*. In the window PLC driver click the button *Add*. If the desired driver is not in the list, then you can install a new driver by clicking on the *Diskette* button. Insert the driver diskette into the diskette drive and click on *OK*.

With PLC-ANALYZER pro you can load the same or different PLC drivers more than once. For example, you can acquire signal data from a SIMATIC S7 and a SIMATIC S5 simultaneously.

8.1.1 Installing additional hardware

If you have already connected your programming unit (or your PC) for programming under STEP7 (or alternative programming software) with the automation device through a PROFIBUS-, Ethernet- an MPI or a PPI interface, then you normally must do nothing else. The following interfaces can be used:

Interface	Explanation
PC/MPI-Cable	Connects the COM port of your PC with the MPI interface of the AD. The PC/MPI cable has the following Siemens Order#:6ES7-972-0CA20-0XA0.
MPI-Card	This MPI component group is meant for operating programming units of type PG730, PG750, PG770, and PCs with ISA bus interface. With this component group (Siemens order# 6ES7-793-2AA01-0AA0) you can interface to the ADs AS300 and AS400. Baud rates of up to 1.5 Mbaud can be achieved for some network configurations.
MPI-ISA on Board	This MPI/PPI interface is a basic component of the programming units PG720, PG740, and PG760, and also the PCs RI45, RI25, and FI25. You only have to make sure of a good connection between the PROFIBUS, the PPI or the MPI interface and the automation device.
CP 5411	The CP 5411 (Siemens order# 6GK1 541-1AA00) is an ISA board for connecting a programming unit or a PC to the PROFIBUS , the PPI or the MPI network.
CP 5511	The CP 5511 (Siemens order# 6GK1 551-1AA00) is a PCMCIA board (PC board) for connecting notebooks and programming units of type PG720, PG740 over PROFIBUS, PPI or MPI to the automation devices AS200, AS300 and AS400.
CP 5611	The CP 5611 (Siemens order# 6GK1 561-1AA00) is a PCI board for connecting a programming unit or a PC to PROFIBUS.
CP 5412	The CP 5412 (Siemens order# 6GK1 541-2BA00) is a ISA board for connecting a programming unit or a PC over PROFIBUS to the automation devices AS200, AS300 and AS400.
CP 1411	The CP 1411 (Siemens order# 6GK1 141-1AA00) is a ISA board for connecting a programming unit or a PC over Industrial Ethernet to the automation devices AS300 und AS400.
CP 1511	The CP 1511 (Siemens oreder# 6GK1 151-1AA00) is a PCMCIA board for connecting a programming unit or a PC over Industrial Ethernet to the automation devices AS300 und AS400.

Table 8-1 Interface types SIMATIC S7

8.1.2 Installing additional software

To use the S7 driver STEP 7 (at least version 3.0) must be installed on your computer. Also you have to install SIMATIC NET, if you want to establish a connection over Industrial Ethernet.

8.2 Configuring the PLC driver

After installing the driver you can set important parameters under *Properties*. If you have loaded more than one driver, then you can set the properties for each driver individually.

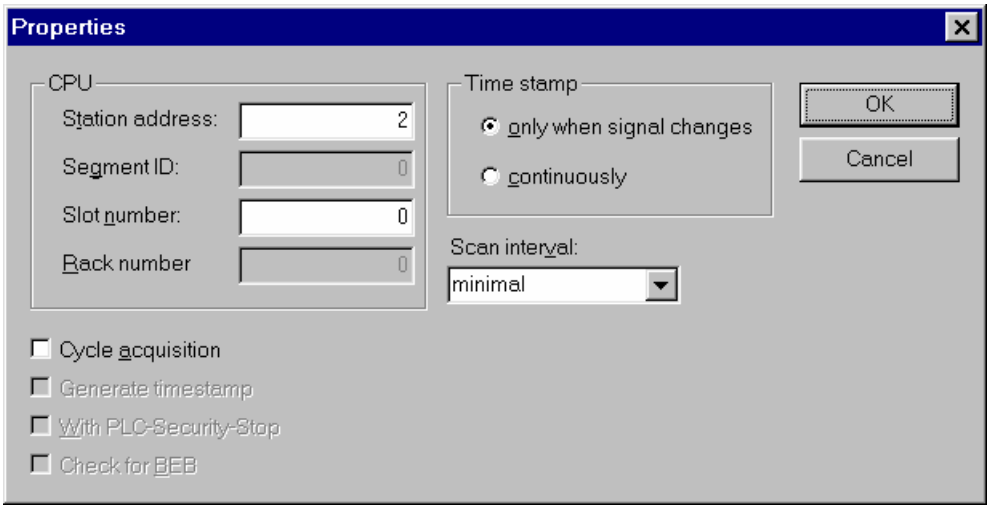


Fig. 8-1 Driver settings (Siemens SIMATIC S7)

Set the *Station address* and the *slot number* of the desired Ethernet[5]-, PROFIBUS-, PPI- or MPI- interface under *PLC address*.

Use *Time stamp* to specify whether the time stamps should be entered into the signal file continually (at every scan point) or only for signal changes. For a continuous time stamp the exact scan points are documented even for a signal which does not change. The signal files are therefore larger.

Under *Scan interval* enter the length of time between read-out of data from the PLC. A longer scan interval may be chosen for non-critical time signals, e.g. temperature. The signal files thus created then become smaller.

8.3 Data acquisition

8.3.1 Supported PLC models and CPUs

The drivers for the SIMATIC S7 family supports all CPUs for the ADs AS200, AS300, AS400, M7, C7 and also the simulation software S7-PLCSIM.

8.3.2 Recordable PLC addresses

The following table shows the recordable addresses and the corresponding address syntax.

Syntax	Address type	Example
Qx.z	Output byte x, bit z	Q32.4
QBx	Output byte x	QB9
QWx	Output word x	QW14
QDx	Output double word x	QD98
Ix.z	Input byte x, bit z	I17.0
IBx	Input byte x	IB127

[5] Only with SIMATIC S7 Ethernet driver

Syntax	Address type	Example
IWx	Input word x	IW12
IDx	Input double word x	ID124
Fx.z	Flag byte x, bit z	F3.7
FBx	Flag byte x	FB250
FWx	Flag word x	FW24
FDx	Flag double word x	FD134
FGx	Flag x (floating-point representation)	FG104
Tx	Timer x	T2
Cx	Counter x	C5
DByDBXx.z	Data byte x, bit z from data block y	DB23DBX2.5
DByDBBx	Data byte x from data block y	DB2DBB5
DByDBWx	Data word x from data block y	DB12DBW5
DByDBDx	Data double word x from data block y	DB27DBD0
DByDBGx	Data x from data block y (floating point)	DB2DBG54

Table 8-2 Address syntax SIMATIC S7

NOTE

The automation devices of the SIMATIC S7 family allow only byte-oriented data acquisition. PLC-ANALYZER pro automatically converts a given bit address to a byte address. All bits are available for display.

8.3.3 Time behaviour and particularities

NOTE

Acquiring data with PLC-ANALYZER pro results in a small increase in cycle time in the automation device to the same extent that happens with STEP7 in operating mode "Watch and control variable".

The intervals between scan transfers from the SIMATIC PLC to the computer are dependent on the PLC CPU, the number of acquired signals and the transmission speed of the Ethernet-, PROFIBUS- or the MPI network.

For the S7-300 the scan interval (with MPI board) for a byte is approximately 25-30 ms, i.e. for a cycle time > 30 ms there is one scan for each cycle. For each additional acquired byte the scan interval increases by about 2 ms.

With Industrial Ethernet (TCP/IP) the minimal scan interval is about 10 ms.

8.4 Cycle-precise acquisition[1]

> **WARNING**
>
> For cycle-precise acquisition PLC-ANALYZER pro programs a small extension to the PLC program in the connected automation device. We call attention to the fact that an effect on the operation of the automation device or the PLC program cannot be completely ruled out.

Cycle-precise signal acquisition provides you guaranteed an acquisition of selected signals of each PLC-cycle without gaps.

During cycle-precise signal acquisition a limited number of signals are acquired in a memory within the PLC. The selected signals are stored in the memory during each PLC cycle and transmitted to the PC in such a clever way that a continuous cycle-precise acquisition is possible.

There is no visible difference in contrast to a normal acquisition for you as an user. Online display can be used as usual.

8.4.1 Installation of additional software

For using the SIMATIC S7-driver the STEP7-Software (at least version 3.0) must be installed on your computer. Also you have to install SIMATIC NET, if you want to establish a connection with the SIMATIC Industrial Ethernet driver.

8.4.2 Installation of additional Hardware

We strongly recommend the usage of a PROFIBUS-, Ethernet- or MPI-card for cycle-precise acquisition. Otherwise you may get gaps in the acquisition.

8.4.3 Configuration of PLC-driver for cycle-precise acquisition

You can set important parameters in the menu *Options – PLC-driver* under *Properties* for the cycle-precise S7-driver. The base configuration of the driver is described in *section 8.2 Configuring the PLC driver*.

[1] The S7-200 doesn't support the cycle-precise acquisition

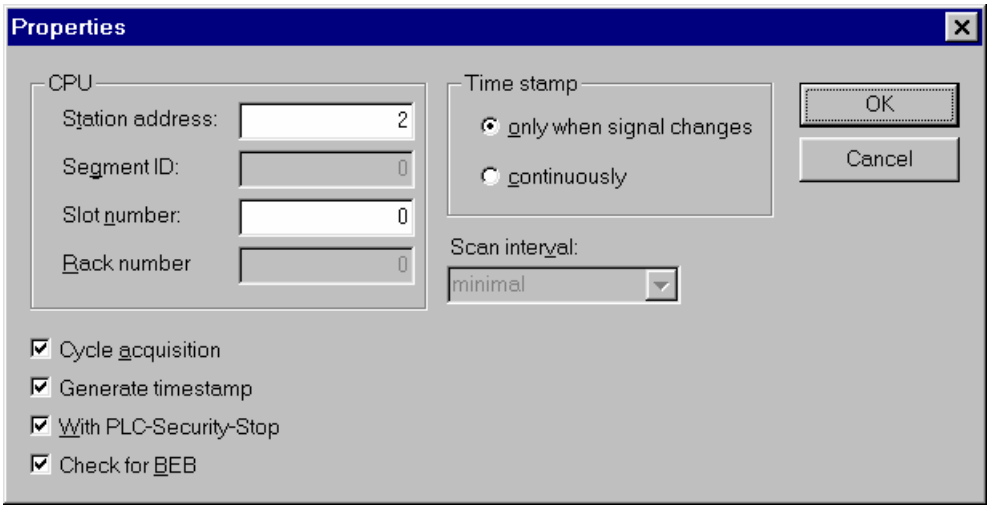


Fig. 8-2 Driver settings for cycle-precise driver (SIMATIC S7)

If you have the cycle-precise version of the driver you can select *Cycle-precise acquisition*.

Generate time stamp is used to associate the time with the data during cycle-precise recording. Deactivate this option when there is so much data to record that data loss results. In this case there will be no time information available during signal analysis.

In addition to that you can choose, if the PLC will be stopped before and after the transmission of the modules to the PLC, by selecting *With PLC-Security Stop* and you can select whether a conditional module end (BEB) should be checked with a corresponding notification. Such a command in OB1 can result in the required modules for cycle-precise acquisition not being executed.

Choose in *Time stamp* whether the data will be stored to signal file continuously for each cycle or only if the signal changes. Following setting is recommended in this connection:

Setting	Description
continuously	Choose this setting, if the signals will probably change in each cycle.
Only if signal changes	Choose this setting, if the signals will probably **not** change each cycle. So you give the PLC-ANALYZER pro the possibility to optimise the recording of the signals and to acquire more signals continuously cycle-precise.

Table 8-3 Driver Settings

NOTE

If more addresses are stored to the memory than can be read from the PLC so a overflow of the circular memory will happen. This means that you lose data. You can avoid this by reduction of the number of addresses which will be recorded.

8.4.4 Input of addresses

You can acquire up to 16 addresses (byte-, word- or double word-values) simultaneously in cycle-precise acquisition mode. This restriction results from the restricted memory capacity of

the PLC and the transmission speed of the PROFIBUS-, Ethernet- or MPI-Interface. A acquisition without gaps is not guaranteed in any case, if to many addresses are recorded. The number of addresses which will be recorded continuously depends on the following points:

- Cycle time of the PLC program
- Setting of the time stamp-option (*see section 8.4.3 Configuration of PLC-driver for cycle-precise acquisition*)
- Transmission speed of the PROFIBUS or MPI-Interface
- Frequency of the signal change
- Recording with/without time stamp

For a cycle time of 2ms with a S7-300 (CPU314) you can acquire ca. 6 bytes without gaps, if the bytes changes each cycle. If the bytes change only each 10th cycle you can acquire ca. 30 bytes continuously without gaps.

8.4.5 Starting acquisition

Select the option *Cycle-precise acquisition* in the *Properties* windows of the PLC driver.

> **!** **WARNING**
>
> It is absolutely necessary to put the system into a safe state before making any modifications. With the setting "With AD safety stop" PLC-ANALYZER pro switches control of module transfer (or modification) into the STOP state. The operation after the end of recording functions analogously.

Now select in the menu *Project* the menu item *Start acquisition*. The modules are transferred either during operation or after control stop, depending on the setting you have made in the PLC driver window *Properties* (see *section 8.4.3 Configuration of PLC-driver for cycle-precise acquisition*). One of the following information windows appears:

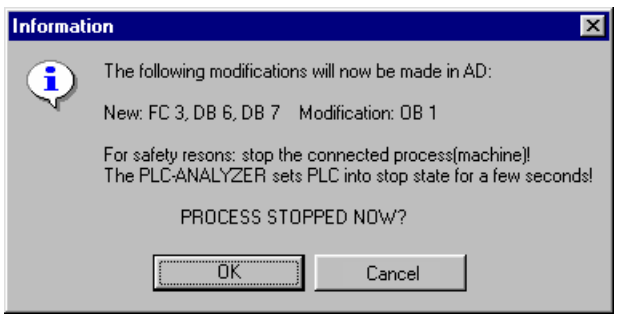

Information
The following modifications will now be made in AD:
New: FC 3, DB 6, DB 7 Modification: OB 1
For safety resons: stop the connected process(machine)!
The PLC-ANALYZER sets PLC into stop state for a few seconds!
PROCESS STOPPED NOW?
OK
Cancel

Fig. 8-3 Message before modifications in the AD for setting "With AD safety stop"

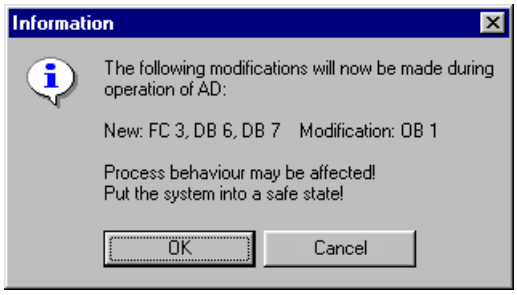

Information
The following modifications will now be made during operation of AD:
New: FC 3, DB 6, DB 7 Modification: OB 1
Process behaviour may be affected!
Put the system into a safe state!
OK
Cancel

Fig. 8-4 Message before modifications in the AD for setting "No AD safety stop"

Confirm with *OK* only after you have stopped the process or put it in a safe state. Make sure that injury or damage cannot happen by affecting control operation!

PLC-ANALYZER pro searches in the PLC for a free module number and creates a function module and a data module for data recording. In addition, a call to the new function module is appended to the end of OB1.

The controller is now in the RUN state or is switched to the RUN state. Cycle-precise acquisition begins. The screen shows online the signal changes.

The acquisition can be stopped with

Recording is stopped with *Stop acquisition*. You should now stop your system (process) or put the system into a safe state. Removal of the modifications is now done analogously in the stop state or online. One of the following message windows appears:

Information
The following modifications will now be made in AD:
Delete: FC 3, DB 6, DB 7 Modification: OB 1
For safety resons: stop the connected process(machine)!
The PLC-ANALYZER sets PLC into stop state for a few seconds!
PROCESS STOPPED NOW?
OK

Fig. 8-5 Message before modifications in the AD for setting "With AD safety stop"

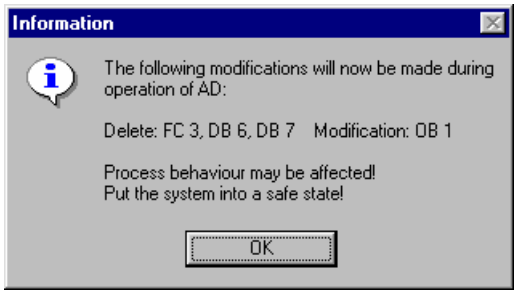

Information
The following modifications will now be made during operation of AD:
Delete: FC 3, DB 6, DB 7 Modification: OB 1
Process behaviour may be affected!
Put the system into a safe state!
OK

Fig. 8-6 Message before modifications in the AD for setting "No AD safety stop"

Confirm the message after you have stopped your system or put it into a safe state. The original state in the AD is now reinstated.

After the end of acquisition the last signal file created is automatically opened for display. The time base is chosen so that the entire file fits onto the screen.

8.4.6 Particularities of signal display and analysis

Evaluation of cycle-precise acquired signal files is identical to normal signal files. However, if no time stamps have been generated during cycle-precise recording, then the time in the signal file is given relatively in cycles. The time base here is "milli-cycles per pixel" (mCP).

If more addresses are stored to the memory than can be read from the PLC so a overflow of the circular memory will happen. This means that you lose data. These gaps in the acquisition are displayed as grey lines.